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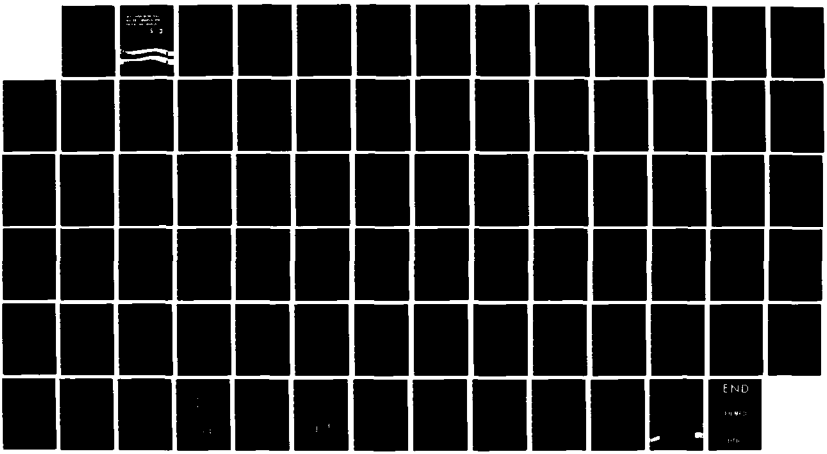

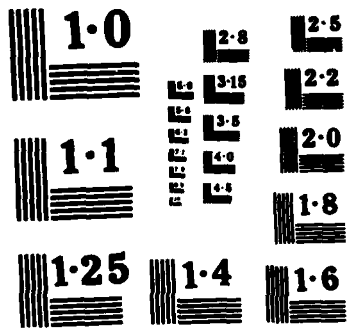

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WISCONSIN MUNICIPAL WATER CONSERVATION PROCEDURES MANUAL

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WATER CONSERVATION
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This manual describes how state communities can develop water conservation plans and forecast water demands for their areas. It is designed primarily for use by public water utilities and DNR Bureau of Water Supply field personnel.

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PREFACE

Although Wisconsin is fortunate in having an abundant supply of both ground and surface waters, various state communities have experienced water shortages for a variety of reasons. Those include drought, contamination, declining water tables, low-yield wells and main breaks. Using water wastefully, although not much of a threat to the short-run water needs of state residents, can overload private septic systems and municipal sewage treatment facilities with costly long-term consequences: increased construction, operation and maintenance costs for treatment facilities; and the increased possibility of polluting receiving waters. Water conservation can not only provide significant savings to water utilities and their customers, it can help assure a continuing abundance of quality water for human, recreational, industrial and agricultural needs.

A feasibility study on the need for a water conservation program in Wisconsin was initiated by the Department of Natural Resources (DNR) about three years ago. Three reports, providing an overview of the problems associated with municipal, agricultural and industrial water-use and a rough estimate of the potential water and energy savings to be realized through increased water-use efficiency were produced by the DNR with the assistance of a statewide advisory group. The reports include results from two surveys, one mailed to all Wisconsin water utilities and one a random-sample telephone survey of state industries with high water-use. As part of this feasibility study, two municipal water conservation demonstration projects were undertaken, one in Cashton and another in Stoughton.

The Cashton project was conducted by the DNR with the cooperation of the Cashton Water Utility and village officials, while the Stoughton project was conducted by the Stoughton Water Utility using conservation devices, materials, and advice provided by the DNR. Recommendations resulting from the feasibility study led to the development of this Municipal Water Conservation Procedures Manual and these two components of it: the prototype Water Conservation Plan for the City of Eau Claire (Appendix C), and the User's Manual for the MAIN (Municipal and Industrial Needs) II model (see Appendix A). This manual describes how state communities can develop water conservation plans and forecast water demands for their areas. It is designed primarily for use by public water utilities and DNR Bureau of Water Supply field personnel. Manuals prepared by the Corps of Engineers Institute for Water Resources (IWR) and the New England River Basins Commission (NERBC) were used in putting this report together.

Both the NERBC report, "Before the Well Runs Dry," and the IWR report, "The Evaluation of Water Conservation for Municipal and Industrial Water Supply," were drawn upon heavily in preparing the Eau Claire water Conservation plan. Materials from both the NERBC and IWR manuals are included herein; portions of both were so applicable that attempts to repeat their work would have been unnecessary repetition.

Municipal and industrial water supply conservation can be effective in achieving a number of community goals, including reduction of investment requirements for meeting anticipated water demand, reduction of waste treatment costs, reduction of operating costs for a system and more equitable allocation of a limited resource.

The kind of water conservation plan pursued by a community depends on the community goals and should be based on its anticipated water demands. The procedures set forth in this manual are based on such initial goal and demand identification.

Wisconsin's water resources may be plentiful, but maintaining that quantity and ensuring its quality depends on community involvement. It takes all of us to really make every drop count.

STATEWIDE WATER CONSERVATION EVALUATION COMMITTEE

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June, 1985

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APPENDICES

Chapter I

OUTLINE FOR DEVELOPING A WATER CONSERVATION PLAN

Developing a municipal water conservation plan involves these seven steps:

1. Identification of community goals;
2. Collection of base data;
3. Analysis of the social acceptability of various conservation measures;
4. Analysis of the technical feasibility of various conservation measures;
5. Development of a "without conservation" water demand projection;
6. Analysis of the effect of combinations of conservation measures that are found to be socially acceptable and technically feasible; and
7. Identification of a water conservation plan.

Each of these steps is described in detail in subsequent chapters.

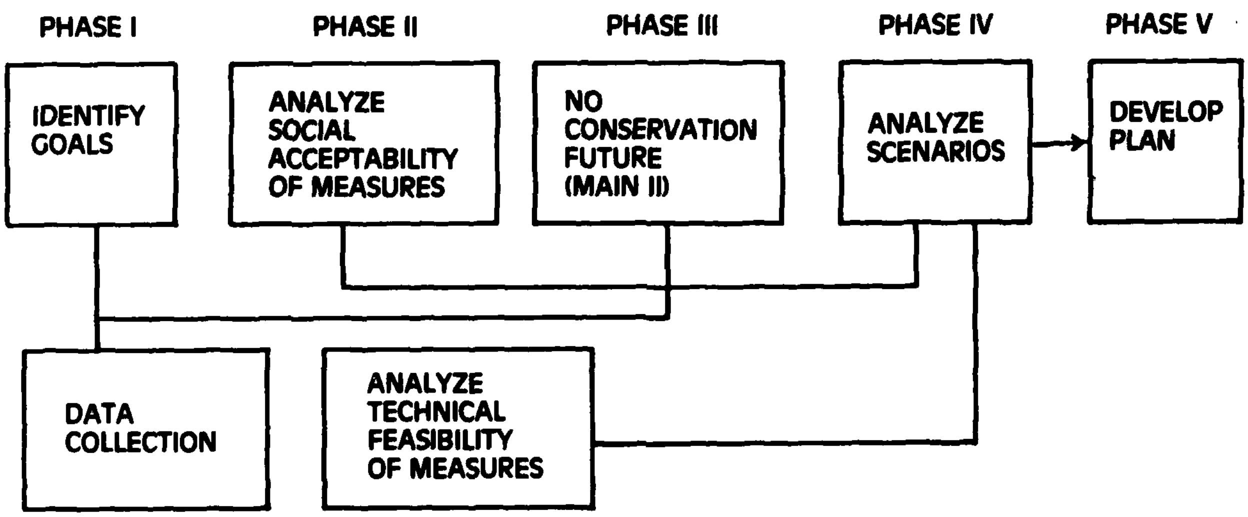
A number of the steps can be carried on concurrently if necessary and feasible. For instance, goal identification will probably be facilitated by information obtained in the data collection phase, and knowledge of the technical feasibility of various conservation measures could narrow the scope of the social acceptability analysis. For steps 3 and 4, the converse is also true.

Step 5, development of an unconstrained -- "without conservation" -- demand projection, depends on the base data collected in step 2 but could be developed at the same time that the social acceptability and technical feasibility of conservation measures are being analyzed.

Steps 6 and 7, analysis of the effect of conservation measures and development of a conservation plan, apply the MAIN II water supply forecasting program. These final two steps must be carried out in order following the completion of steps 1 through 5.

Given the constraints outlined above, the manner in which the study is done depends on a community's urgency to carry it out and the staff available to work on it. Figure I-1 provides a graphic presentation of the relationship of these steps.

Figure I-1
Municipal Water Conservation
Planning Procedure



Chapter II

IDENTIFYING COMMUNITY GOALS

The introduction to this manual noted that evaluating the social acceptability of various conservation measures is a critical step in water conservation plan development. The results of both the community leader and public surveys described in chapter IV should be used in identifying community goals.

The purpose of goal identification is to determine what conservation solutions are applicable to the water supply problems of a particular community. To make such determinations, the problems needing solution must first be identified. These questions should be asked:

1. Does peak use need to be reduced?
2. Does average daily use need to be reduced?
3. Is the needed reduction a high or low percentage of total use?
4. Is the needed reduction long-term or short-term?

The above questions are designed to address the following water supply problems:

- excessive energy consumption;
- excessive wastewater treatment requirements; and
- inadequate supply (resulting from drought, contamination, inadequate groundwater resources, inadequate surface water sources or storage, an inadequate delivery system and/or inordinately high user demands).

If the desired reduction in use is between 1 and 20 percent, that goal can probably be achieved through conservation. Generally, a range of 1 to 10 percent is considered low and a range of 10 to 20 percent high for use-reduction to be achieved through water conservation.

Another factor important in evaluating conservation needs is the determination of whether problems are limited to peak use or apply to average use. If supply problems are severe, both types of use may need reduction.

Successful goal identification will make use of initial perceptions as to the types of problems existing and the direction that a conservation plan should take. Surveyed public works staff will identify the general level of water-use reduction necessary (more or less than 10 percent), the level of residential consumption (more than 60 gallons per capita per day) and the amount of pumped water that is unaccounted for (more or less than 20 percent). The public utility's perceptions regarding how long reductions will be necessary is also important. This latter question addresses whether average use must be reduced and whether use must be reduced over a short or relatively long period (greater than 5 years).

Examining the preceding questions will help communities assess whether reductions should be sought through "supply management" or "demand management." Supply management is achieved within the utility through metering, leak detection, pressure reduction, watershed management and evaporation suppression, while demand management is carried out with programs directly affecting the user. Pricing, regulation and education are examples of such measures. Both supply and demand management programs have special features affecting their application to water conservation programs.

Supply management programs:

- are not dependent on consumer cooperation;
- meet long-term goals;
- are most applicable to average demand problems but can reduce peak demand problems if these problems are caused by inadequate system capacity;
- are the best method if the conservation goal is a relatively low percentage of total use;
- can have high costs (expenditures); and
- do not result in lost revenues.

Demand Management Programs:

- require consumer cooperation;
- are applicable to both short-term and long-term goals;
- can be used to solve average and/or peak demand problems;
- can achieve low or high percentage reductions;
- can be relatively low cost;
- can lead to lost revenues; and
- can be mandatory or voluntary.

Chapter III

COLLECTING BASE DATA

Water-use forecasts for the period to be analyzed will need to be developed, and their degree of accuracy -- and therefore the accuracy of the measure of the water conservation plan itself -- depends on the level of detail of the base data collected.

Accurate forecasts are best made when current use information is disaggregated and separate forecasts are made for each water-use sector. Data on current use should therefore be obtained for the following sectors:

- residential, both seasonal (outdoor, such as lawn irrigation and car washing) and nonseasonal

- commercial (retail, wholesale, office, hospital, schools, restaurants, services, etc.) The Department of Public Works records included Eau Claire multi-residential structures in this sector.

- industrial
(Interviews of major industries are necessary to determine whether they are "wet" or "dry". I.e., Pepsi Cola would ordinarily be "wet," and it is so assumed by the MAIN II model. The Pepsi Cola facility in Eau Claire was, however, only a warehouse. Its principal water use was truck washing. Interviews will also determine if the industry has its own water supply in addition to the municipal supply, as was the case for Pope and Talbot Paper.)

- public (fire protection, line flushing, airport, unaccounted for, etc.)

At the minimum, data should be disaggregated into residential, nonresidential and public. Figure III-1 is a list (taken from "The Evaluation of Water Conservation for Municipal and Industrial Water Supply - Procedures Manual") of sample data that should be collected by communities.

Analysis of this data, based on the evaluation procedures set forth in the Wisconsin Municipal Water Supply Conservation Needs Index, will identify those sectors where water conservation measures are most applicable. This information, in turn, will aid in goal determination (specifically, in deciding whether supply or demand management is most appropriate).

The data identified in figure III-1 reflect information necessary in forecasting water use. The importance of obtaining the best possible data at the highest level of detail cannot be overemphasized.

Figure III-1

SAMPLE DATA REQUEST TO RELEVANT WATER AND SEWER AUTHORITIES

A. From water billing records:

1. average water-use per dwelling unit (or connection) for each billing month for each customer class for the past five years

2. the number of connections for each customer class for the past 10 years

3. the amount of water wholesaled (to other communities) for each month for the past five years

4. a list of the name, address, and amount of water purchased by the largest customers (The identity of these customers will not be revealed in the report. Of particular interest are golf courses and other facilities that can use recycled water.)

B. From water utility, community public works, DNR and Wisconsin Public Service Commission records:

1. the total amount of water produced and sewer flow for each month of the past 10 years

2. maps of the major sewer and water mains

3. the number of miles of water mains of various sizes

4. water and sewer rate schedules for the past five years

5. total water and sewer revenues received for the past five years

6. the results of past leakage tests

7. the costs of past leakage tests

8. description of the current metering program

9. the current status of meter verification and inspection programs

10. any data relating to peak-day water-use by large water users

11. annual water and sewer operation, maintenance, and repair (OM&R) budgets for the past 10 years

12. any other data that would assist in determining the relationship between water produced and OM&R costs

13. capital improvement programs for water supply and wastewater treatment for the next 50 years

14. any planning documents or consulting reports prepared for projected capital improvements

15. water-use and sewer-flow projections for the next 50 years

16. any data relating to actual or proposed water recycling or groundwater recharge plans

17. current treated effluent water-quality conditions

18. any available data relating to the effects of water-use or future water-use changes on other uses of water supply sources. (For surface sources, such data may include altered patterns of hydroelectric generation, inland navigation, recreation, water supply for other localities, etc. For groundwater sources, the data may be of the nature of increased pumping costs (both for the utility itself and other users), land subsidence, wildlife impacts, etc.)

19. data on any programs, plans, or policies, not discussed above, that relate to water conservation of drought management

Chapter IV

SOCIAL ACCEPTABILITY ANALYSIS

Community attitudes toward such conservation measures as pricing, education, and water-use regulations must be known prior to the design of any water conservation plan. Without such information, a utility could design a conservation plan that community resistance would make impossible to implement.

The procedures outlined below for identifying the social acceptability of water conservation options were developed by the Corps of Engineers Institute for Water Resources.

STEP 1: INITIAL IDENTIFICATION OF ADVISORS

Based on their experience with the community, those preparing the water conservation plan should select a group of "advisors." These advisors should be people who are expertly familiar with the issues of environmental and social concern to the community (such as land use policies or water rates) and with the interest groups associated with those issues (such as a Chamber of Commerce or homeowners).

STEP 2: IDENTIFICATION OF ENVIRONMENTAL AND SOCIAL ISSUES, AND OF INFLUENTIAL INDIVIDUALS, AND ORGANIZATIONS

Open-ended, informal interviews should be conducted with the community advisors to achieve two goals: first, to delineate the environmental and social issues most relevant to the community; second, to identify specific individuals who represent various organizations of groups in the community who would take positions on such issues.

STEP 3: SAMPLE SELECTION AND QUESTIONNAIRE DESIGN

The list of issues identified by communities in Step 2 shows, in part, the areas that the study will investigate. In addition to such general issues, however, the study should also explore responses to specific conservation measures of particular local relevance.

These responses should be obtained from a target, personal interview sample of those influential citizens identified in step 2, and a random, mail questionnaire sample of the community's general population. An interview guide should be designed for use in the personal interviews, with questions aimed at achieving these two goals: evoking responses that will illuminate the fundamental values, beliefs, attitudes and feelings that make up the ideological context within which any specific conservation measure proposed will be evaluated, and determining interest group response to specific conservation measures.

The questions in the mail questionnaire should be limited to exploring public responses to specific conservation measures.

STEP 4: DATA COLLECTION

In brief, interviews should be conducted so as to encourage cooperation from targeted people and yield desired data. Similarly, the general public mail survey should be handled in ways that encourage a high rate of return.

STEP 5: DATA ANALYSIS

Data analysis involves ordering, abstracting, and statistically manipulating data, followed by interpreting it. In analyzing the interview data, the primary goal should be identifying and delineating core ideologies (values, attitudes, beliefs, and feelings) characterizing the community. A secondary goal should be determining interest group responses to a range of specific conservation measures.

The goal in analyzing data from the mailed questionnaire is determining the unaligned, general public's response to a range of specific conservation measures. Hopefully, this process will provide insights on both the public's receptivity to specific water conservation measures and on what factors affect those perceptions.

STEP 6: DETERMINATION OF SOCIAL ACCEPTABILITY

A conservation measure will be socially acceptable if it does not violate the values, attitudes, beliefs and feelings defining a community's commitments. Determining the social acceptance of given measures is accomplished by examining each in the light of the community ideologies uncovered in steps 1-5 above. As each conservation measure is reviewed, study data will partially answer such crucial questions as who in the community would support it and why, and what it would take to turn opposition into support. If the study fails to answer such questions definitively, it can at least provide some helpful information.

In analyzing any one measure's social acceptability, keep these questions in mind:

- Does the data identify any initial social impediments to implementation?
- Does the data provide any information which could prove useful in water conservation measure formulation?
- What information needs of the public -- and of specific public sectors -- are revealed regarding water conservation measures? (This latter information is particularly valuable to public participation programs.)

Figure IV-1 presents the steps involved in determining a measure's social acceptability.

Figure IV-1

MEASURING THE SOCIAL ACCEPTABILITY OF WATER CONSERVATION MEASURES

STEP 1 Initial Identification of Advisors

STEP 2 Identification of Environmental and Social Issues, and of Influential Individuals and Organizations
- Open-ended general interview with advisors

STEP 3 Sample Selection and Questionnaire Design
- (1) Advisor sample
  - -- Select
  - -- Design interview guide
- (2) General public sample
  - -- Select sample audience
  - -- Design mail questionnaire

STEP 4 Data Collection
- (1) Advisors -- the interview
- (2) General public -- the survey questionnaire

STEP 5 Data Analysis
- (1) Advisors
  - -- Ordering and abstracting of individual statements
  - -- Interpretation
- (2) Data on general public
  - -- Frequency distribution of responses
  - -- Interpretation

STEP 6 Determination of Social Acceptability

Chapter V

TECHNICAL FEASIBILITY OF CONSERVATION MEASURES

Many water conservation measures are available to a community. In making choices among them, the technical feasibility of their application should be considered.

The following provides descriptions of various measures, categorizing each under either supply or demand management. The applicability of the categories depends on what water conservation goals a community has set, and characteristics of the measures should be reviewed with these goals in mind.

SUPPLY MANAGEMENT

WATER AUDIT AND LEAK DETECTION

If a community has significant unaccounted-for water caused by leaks, it will probably need a water audit. This is a combination of flow measurements and scanning. First, all measured water flows (i.e., metered water) are tabulated. Second, measurements are taken of water actually flowing through the distribution section. The two figures are then compared and if a water surplus appears in the distribution system but doesn't appear in the meter readings, a detailed survey of the distribution system is conducted. Meters are checked to determine if they are registering properly.

Through such an audit, a community can reduce water leakage, correct meter malfunctions, increase pump efficiency and develop more accurate system records. All of this can significantly reduce annual operating costs while increasing revenues, energy conservation, and operation and maintenance efficiency.

The audit accounts for all water supplied by a utility and thoroughly examines the distribution system carrying that water. A complete water audit usually consists of these three basic elements: meter testing, leak detection and quantification, and system inventory. Although each of these can be conducted separately, when conducted together they not only account for total water flow through the system but catalog system components and their condition as well.

Because a water utility's meters provide the basis for determining income and accountability, it's important that the meters be accurate. Where large commercial industrial and master meters have not recently been tested or where their accuracy is questionable, meter testing is a top priority. It is recommended that in-place testing under actual operating conditions be the first element of a water audit. This can be accomplished by inserting a pilot rod to measure the rate of flow.

A successful leak detection and quantification program, the next step in an audit, requires a thorough knowledge of the water distribution system. Therefore, prior to taking measurements, a detailed examination of system records should be made. Once this is done, the distribution system should be divided into major supply districts, each capable of being measured at one or two points. Flows should be measured over a 24-hour period, with the ratio between the maximum night flow rate and the average consumption for a district examined to determine the need for more detailed investigations. Where high night flow rates indicate potential leakage, the districts should be divided into subdistricts for further testing.

Leak detection in these subdistricts is based on the principle that leaks make noise, a result of energy lost when water escapes through the pipe wall or when soil and stone particles are disturbed outside the pipe. These sounds can be detected with either mechanical or electronic sound-intensifying equipment. The listening devices should be employed at house connections, hydrants, valves and on street pavements. Quantification is made possible through the subdistrict measurements made earlier.

District and subdistrict measurements should show that approximately 80 percent of the valves in the distribution system have been operated, as well as more than half the hydrants. The final water audit step is to record their condition, along with notations on the many curb stops that have been located as listening points. This information should all be added to existing operating records to provide a thorough and up-to-date accounting of system components. Computer-aided mapping services can assist in cost-effectively producing accurate system maps, invaluable for quickly locating hydrants and valves in emergencies (fires, main breaks, etc.).

The costs of leak detection and repair programs vary considerably. A system scan employing listening techniques would cost about $5,000 to $10,000 per year for a community of 5,000 people. Other leak detection programs -- such as water audits, usually done by consultants -- tend to be more expensive. Repair costs depend on the size and type of repair; costs to replace leaky hydrant parts can be as low as $100, whereas costs to repair pipes -- requiring a crew, backhoe and repaving -- can be as high as $1,500 for even a small section.

If a community has high water loss tracked specifically to leakage, a scan of the system using listening equipment would be appropriate. The most widely used equipment includes the aquaphone, the geophone, and electrosonic instruments, the latter being particularly effective at filtering out background noise.

A 1980 study revealed the following figures on the costs and benefits of leak detection and repair programs:

SURVEY YEAR	NUMBER OF LEAKS	WATER SAVED	NET BENEFITS
1975-76	182	5,092,706	$114,170
1977-78	179	2,711,468	$ 23,699
1979-80	137	2,664,663	$ 24,492
1975-80	498	10,468,837	$162,361

Total leak detection and repair costs over the 5-year test period were $239,052, while water saved totaled $401,413.

METERING

Metering is not an actual conservation technique in itself, for it neither reduces water loss nor encourages use reduction. However, it does provide an accurate account of all water uses throughout the system, and can therefore be used in supply management programs (leak detection and repair, for instance, as well as in other demand management programs).

A cost-effectiveness study should be done before metering is put into effect. The cost of meter purchase and installation varies according to the size of the meter. The cost of a 5/8-inch meter, used in most residential installations, can be as high as $50 while larger ones, such as turbine types for high-volume users, will run approximately $70 for a 3/4-inch, $100 for a 1-inch, and $550 for a 3-inch meter.

The costs of regular meter maintenance programs (i.e., testing and repairing) are competitive with the costs of regular meter replacement programs. Meter testing and subsequent repair work can total as much as a new meter or replacement parts cost. Many utilities purchase plastic meters as a means of lowering their meter replacement costs. These are just as accurate and reliable as metalbody meters yet can be thrown out once worn.

Zoning is the suggested organization for metering. This is usually done by dividing the city up into quadrants, often in some multiple of four -- for instance, dividing by major roads into an east-west quadrant and a north-south quadrant. This type of organization will help narrow down the locations of leaks existing in or repairs needing to be done in specific quadrants. Remember that education and public involvement are essential here. Also, a quarterly meter reading can be established to provide a good background on community water use. Quarterly meter reading and billing can also improve cash flow substantially.

In many cases, some of the community is already metered, but metering the entire town will improve the community's replacement program maintenance.

DEMAND MANAGEMENT

PRICING

A properly designed pricing program can earn extra revenues even as consumption drops, so pricing should definitely be considered in developing water conservation programs.

Unmetered municipal utilities cannot use pricing, however, as their water charges are not based on consumption. Pricing as a demand management program is most effective for long-term, low percentage, average or peak goals. To date, it has been shown to be most effective in encouraging the reduction of residential peak use and of commercial/industrial average use. Response to price hikes usually diminish as users become accustomed to paying more, but as price levels increase for supplied water as well as wastewater treatment users' responses are likely to increase. Industry usually responds to increased wastewater treatment costs by implementing water conservation measures.

Pricing program costs are mostly one-time. Communities choosing this option need to do a rate survey, or cost of service study for its system (around $1,500 for a small community and up to $40,000 for a large system), and set up a new billing system. If the utility is regulated (municipally-regulated and investor-owned utilities), a lawyer or private consultant will be needed to present the new rate to the public utilities commission.

Reduction percentages will vary, but more reduction in peak than in average use can be expected. The town of Hanover, Massachusetts, increased its water prices by 70 percent and achieved a 15 to 20 percent decrease on peak use and a 3 to 5 percent decrease on average use.

Opposition from users, local governments, and the public utility commission is pricing's major disadvantage. Local governments like to keep water prices low to attract industry, so if the utility is regulated, pricing as a conservation measure is not likely to win approval. Most states do not even allow pricing for water conservation, although some are considering changing that policy. California allows pricing both to encourage conservation and for recovering revenues lost through the use of other conservation programs. If a utility or community does choose pricing as a conservation measure, it will have to design a new water rate. Changes in both price level (price per unit of water) and structure (price level variations according to quantity used or time of use) are usually necessary, price level being the most important of the two. This is so because, regardless of price structure, users will reconsider their water use and begin conserving only when the price level is high enough.

New water rates should be designed to accomplish the following:

1. encourage the needed use reduction
2. cover the total cost of service
3. minimize adverse impacts

Any water rate has the ability to recover total service cost(s) if the price level is high enough. Comparison(s) of cost(s) to new revenues must include all costs, even those of the conservation program itself. Also, it is important to make only one price hike within a short period of time. Otherwise, the utility may face overwhelming opposition and a loss in user confidence, making another rate hike virtually impossible.

Regardless of how new utility rates are designed, some opposition is almost certain. Educational program(s) explaining why rate increases are necessary and offering consumers conservation tips for keeping their bills low will serve to minimize negative responses, however.

Generally, as the price for any product goes up, demand goes down. As the price for water increases, users generally reduce their use. Achieving the desired use-reduction requires accurate estimates of what user responses to the new price will be, referred to as the elasticity value. The elasticity value is simply the arithmetic value of the users' response. It is expressed mathematically as follows:

$$\text{Elasticity} = \frac{\%\ \text{Change in Water Used}}{\%\ \text{Change in Price}}$$

If users responses are high, the elasticity value will be high. If they are low, the elasticity value will be low.

The factors that influence elasticity values are:

1. the new price level (the lower the price, the lower the response)
2. average user income (the higher the income, the lower the response)
3. average number of people per household (the larger the number, the lower the response)
4. the average rainfall and temperature (the more temperate the climate, the lower the response)

In order to choose the appropriate elasticity value, individual communities will need to review each factor influencing elasticity. Communities must determine which factors are significant for them and then select a value accurately reflecting how their users will respond to a price increase. For most communities, elasticity values will be among the lower of those presented previously. If two or more distinct user groups -- such as small-volume residential users and large-volume industrial users -- are in a community, it should select a separate elasticity value for each group.

Price structures, of which there are about 12 different kinds, are used to modify price levels so that the total water rate (level and structure) can achieve one or more of the following:

1. Reduce demand to achieve the desired conservation goal.
2. Cover the true cost of supplying water.

3. Be fair to all users in the community.
4. Reflect the point at which user demand in a given community is influenced.
5. Be politically acceptable.

The following types of price structures are available:

1. seasonal

   -- price level varies during peak use season(s) (i.e., higher in summer than in winter)

2. peak load

   -- price level higher during daily peak use hours

3. excess use

   -- price level significantly higher for all above average water use, usually determined by winter use

4. decreasing block rate

   -- price per unit decreases as consumption increases

5. uniform block rate

   -- price per unit decreases as consumption increases

6. sliding scale

   -- price level per unit for all water used increases with average daily consumption

7. increasing block

   -- price per block increases as consumption increases

8. hook-up fee based

   -- charge special fee at time of connection

9. tax incentives

   -- community gives tax credits or reductions to users implementing other conservation methods

10. average variable

    -- price per unit varies according to actual expenditures during billing period

11. spatially price-based

-- user pays for actual costs of supplying water to his establishment

12. scarcity price-based

-- cost of developing new supply attached to existing use

EDUCATION

Education can be the key to a water conservation program's success, as it can help users understand why conservation is needed and how to achieve it. It can also successfully minimize opposition from community officials. Past studies have shown the use of education programs alone, in fact, to reduce water use by as much as nine percent. In Madison, Wisconsin, education programs helped flatten high use peaks and eliminate a need for new well. Such percentage change(s) will not, however, remain stable over a long-term period. The programs are only effective in attaining high percentage-reduction goals on a short-term basis. To maintain such percentage changes, education programs need to be repeated often so that users will not forget the steps involved.

Education program costs affect both the community and the utility. Depending on the community's size and the intensity of the program, the costs can include a loss in the utility's revenues, brought about by resulting consumer conservation. Forecasing education program results is not really reliable, though, due to the programs' voluntary nature.

Two major factors should be considered in designing water conservation education programs: the type of community and the program budget. The following offers some suggestions on how to successfully convey information to the public:

Inexpensive Methods:	Expensive Methods:
1. local newspaper articles	1. local newspaper ads
2. posters and public displays	2. information centers
3. fairs	3. speakers bureau
4. contests	4 billboards
5. distribution of reminder items	5. TV, radio ads
6. school programs	6. films and slides
7. bill inserts	7. water-saving fixture test programs
8. pamphlets and handbooks	8. direct customer assistance
9. newsletters	

Any of these methods can be designed and written to achieve any type of conservation goal. Method choice should depend on effective transmittal of information in the community in question. Usually, a combination of approaches most effectively ensures that all users are exposed to the information.

School programs should be considered by the utility or community regardless of conservation goal aims. Such programs can teach children water-saving habits which they in turn may pass on to their parents.

REGULATION

Regulation can take any form needed, but it is usually used in these ways:

1. to restrict a specific water use
2. to restrict the time when specific uses are allowed
3. to allow specific uses (for example, filling swimming ponds) by permit only
4. to require the installation of low-flow water appliances only

Communities should reserve the use of stringent regulations like rationing and use-bans for high percentage-reduction short-term goals or for times of extreme emergency, such as an extended drought. User opposition may otherwise be enough to substantially reduce cooperation.

Less stringent regulation, such as plumbing code changes and limits on specific uses, should be used for long-term, low percentage goals. These regulations are usually well accepted.

Most regulations limiting outdoor uses are also easy to implement and can achieve water use reductions immediately. Some regulations limiting average use -- plumbing codes, appliance retrofit, rationing and hook-up moratoria -- however, will require a great deal of work before community government approval is won. Therefore, unless a community is experiencing a water crisis, a long lead time will be needed to get these types of regulations implemented.

All regulations require some level of enforcement, so the community or utility -- whichever has the relevant authority -- should deal with any staffing increasing necessary for enforcement in advance of issuing regulations. Otherwise, the regulation(s) may have little impact. Where a utility lacks the authority and/or manpower to enforce regulations, the help of the local government or police department may have to be secured.

Regulation's major disadvantage is that revenues will decrease along with water use. (Note: Municipal-unmetered utilities will not experience a revenue loss as their water charges are not based on consumption.) Another disadvantage is that some users may oppose or ignore water-use limitations. Costs for regulation implementation are minimal, generally limited to those of enforcement.

If a utility is able to overcome the revenue problems that accompany regulation, it should consider this option as part of its conservation program. It is an effective and reliable demand management choice.

Regulation options for average demand problems include:

1. restricting quantity

   - -- rationing: for both low and high percentage-reduction short-term goals
   - -- moratorium on new hook-ups: for low percentage-reduction short-term goals

2. restricting use

   -- restaurants serving water only on request: for low percentage-reduction short-term goals

3. requiring special equipment

   -- plumbing code changes: for low percentage-reduction long-term goals
   -- appliance retrofit: for low percentage-reduction long-term goals

Regulation options for peak demand problems include:

1. restricting use

   -- ban car washing, irrigation, etc: for high percentage-reduction with both short- and long-term goals

2. restricting time

   -- limit car washing and landscape irrigation by months and/or days: for both low and high percentage-reduction short-term goals

   -- limit hours for car washing, irrigation, etc: for low percentage-reduction of long-term goals

3. requiring special equipment

   -- landscape irrigation with hand-held hose only: for low percentage-reduction of short-term goals

4. requiring permits

   -- to fill swimming pools: for both low and high percentage-reduction long-term goals

These are just a few regulation combinations that have been used in past studies. If others would be more effective for a particular community, those methods should be used. Whatever choices are made, however, be sure that the community supports them.

WATER-SAVING FIXTURES

Fixtures can be used to achieve any type of conservation goal. Using them to achieve average, short-term, high percentage goals, though, may be ill-advised, as fixtures able to achieve such reductions are very expensive. Also, choosing and installing water-saving fixtures is usually done by the user, so a demand management program -- dependent on consumer cooperation -- would be unrealistic here; users could opt to choose any fixture that they liked or none at all.

Many utilities have developed aggressive education programs in this area, however, telling users which fixtures are best, where to get them and how to install them. Some utilities have even bought conservation-efficient fixtures and sold them to users at cost. Other utilities have bought fixtures, distributed them and installed them in users' homes or businesses. All types of programs have been successful in varying degrees, but the most effective has been when purchase, distribution and installation has been done by the utility. Even though this type of program is expensive, it can be cost-effective.

The most successful water-saving fixtures are those which operate in a manner like conventional ones. Among these are:

1. toilet tank inserts (dams, bottles, sleeves)
2. shower flow restrictors
3. low-flow showerheads
4. hose attachments
5. automatic shut-off valves (public lavatories of industrial/commercial use)

Utilities should encourage users to install plastic bottles (toilet tank inserts), faucet aerators and shower flow restrictors for retrofit. Dams for toilet tank inserts are somewhat more difficult to install, require periodic adjustment, and are not suitable for all toilet tank designs. Utilities should also encourage users to install shallow trap toilets and low-flow showerheads in new houses or when replacing old ones. They should encourage industrial/commercial users to install automatic shut-off valves in their water distribution systems. Encouraging users to buy hose attachments in response to any type of peak use conservation goal is another good idea.

If such water-efficient fixtures are installed in a majority of homes or businesses, an average use-reduction of up to 15 percent is possible. These fixtures should reduce short-term as well as long-term use.

There are about 60 different varieties of water-saving fixtures, 20 of which are versatile enough to be used widely and all of which are capable of reducing water use.

Water-saving fixtures for average demand problems include:

1. shallow trap toilets
2. dual flush toilets
3. toilet tank inserts
4. faucet aerators
5. shower flow restrictors
6. vacuum flush toilets
7. hot water pipe insulation
8. pressurized flush toilets
9. fog and spray nozzles
10. multiple rinse tanks
11. automatic flow regulators
12. counter-flow rinse devices

Water-saving fixtures for peak demand problems include:

1. time-controlled sprinkler
2. drip irrigation systems
3. swimming pool covers
4. hose attachments
5. moisture indicators
6. tensiometers
7. variable flush
8. instant hot water

Chapter VI

DEVELOPMENT OF A "WITHOUT CONSERVATION" DEMAND PROJECTION

Deciding whether a water conservation program is necessary for a community depends on its projected water demand. Such forecasting of future needs indicates whether existing supplies and facilities are sufficient. If they are not, the community can evaluate the feasibility of expanding its present supply system and/or instituting water conservation to reduce demand.

Actual development of a water conservation plan for a community also requires this water demand projection. Called the "without conservation" plan, this forecasting is necessary for many reasons:

1. Demand projections indicate whether there will in fact be a future water supply problem.

2. Knowing the extent of demand growth helps measure the severity of future water supply problems.

3. Knowledge of anticipated future demand helps narrow down which conservation operations are most feasible for a particular community's water demands. (As noted earlier, water conservation measures can reduce the amount of water provided by as much as 20 percent.)

4. A projection of disaggregated uses (residential, commercial, industrial and public) identifies the sectors with the greatest growth, helpful in deciding which conservation measures most appropriately fit a particular community's needs.

Appendix A discusses a computerized water-use forecasting system called MAIN II. Recently revised and modified to broaden the scope of its usefulness, the MAIN II model was used in preparing Eau Claire, Wisconsin's water conservation plan (see manual preface and Appendix C). It is recommended for use by other state communities in water supply forecasting and conservation plan development.

Chapter VII

ANALYSIS OF CONSERVATION MEASURE FEASIBILITY

Identification of the water conservation measures most feasible for a particular community is based on the technical feasibility of the measures, their social acceptability, and on implementation costs.

Conducting a cost analysis of implementing various measures requires:

1. projections of water supply operating costs
2. water supply capital improvement plans
3. projections of wastewater system operating costs
4. wastewater system capital improvement plans

The benefits of any water conservation efforts are measured as foregone supply costs. These and other cost categories follow:

1. foregone costs: supply, transmission, treatment, storage, distribution and wastewater treatment costs
2. short-run incremental costs: variable; include those operation, maintenance and administrative costs which vary with use
3. long-run incremental costs: costs which vary with a supply facility's capacity

Analyzing each of these categories requires three major steps: cost identification, data collection and an estimation of the incremental cost functions for individual costs within each category. The following discusses these steps in relation to the three cost categories listed above.

SHORT-RUN INCREMENTAL SUPPLY COSTS

IDENTIFICATION

Short-run incremental supply costs include many of those expenditures that are normally categorized as operation, maintenance and repair (OM&R) costs. A useful distinction can be made between those OM&R costs that are related only to the size of the capital stock (fixed short-run costs) and those OM&R costs that are variable with use, given a fixed capital stock (variable short-run costs). Only the variable short-run costs should be included in estimates of short-run incremental costs.

Incremental short-run costs should never be less than the average variable short-run cost. In an efficient production facility, the cheapest units of output are produced first. Therefore, the average variable cost of producing all units is not greater than the variable cost of the last unit produced (which is the incremental short-run cost). Short-run incremental costs are represented by the slope of the function that relates total OM&R costs to total output.

The above discussion indicates that short-run incremental costs (dollars per unit) can vary with changes in use. As total output approaches capacity, incremental costs rise rapidly. Additions to capacity will, therefore, affect the value of incremental costs.

Short-run incremental costs can also include items that are not included in the OM&R expenditures. This situation can result because certain resources used by the utility may be obtained from other city agencies at no charge. A utility can also impose costs upon itself that are not segregated in expenditure data. This is particularly true for groundwater pumping where each unit pumped can increase the cost of other units pumped.

DATA COLLECTION

Projected short-run costs for the plan are obtained from documentation of the water supply plan. Interviews with water utility personnel can also be helpful. Some utilities use their treatment plants or wells in the order of least costly first; thus, the variable costs associated with the highest cost plants or wells are the incremental costs. These costs must usually be discovered through interviews with utility personnel.

ESTIMATION

Before the cost functions can be estimated, several operations should be performed on the OM&R budgets. Only actual expenditures, rather than appropriations, should be used. All obvious fixed (with respect to water use) costs (administration, billing, water quality monitoring, etc. should be moved. If major discontinuities separate old and new data, the older data should be discarded.

Average variable (or potentially variable) cost values can be useful in setting bounds on incremental cost values. Further refinement can sometimes be achieved through the use of regression of short-run cost or water use or sewer flow. A very limited number of other variables (number of connections, for instance) should be included if thought to significantly influence water use. Repeated attempts to fit variables of functional forms should be avoided as this can seriously bias regression statistics.

LONG-RUN INCREMENTAL SUPPLY COSTS

IDENTIFICATION

Long-run incremental supply costs represent the advantageous effects associated with use reductions that allow water and sewer utilities to delay or reduce future capital expenditures without reducing the quality of service. Identification of these costs requires knowledge of the capacity expansions included in the plan and likely to be planned, as well as of the parameters of water use that determine the time of construction of each facility. Among the parameters of use that determine the timing of capital facilities are average-day use, maximum-day use and average-day sewer contributions.

DATA COLLECTION

The most valuable data sources are the planning and consulting reports. These reports very often describe how the timing and sizing determinations are made. Supplemental interviews with utility employees and consultants are often necessary.

ESTIMATION

The procedure for estimating long-run incremental cost functions involves estimating the present value of changes in the capital improvement program that are likely to result from sustained changes in water use. These changes estimated separately for federally and non-federally planned facilities, can then be annualized to provide annual cost savings that can be compared to annual water-use reduction. These functions are likely to be nonlinear and discontinuous if taken over large changes in water use. The foregone cost per unit of water saved can also vary with the time the water savings are initiated. Once a large capital facility is completed, changes in water use cannot affect its costs. Delaying a capital facility can save not only capital costs, but also the fixed portion of OM&R costs related to the size of the capital stock during the time of delay. All capital and OM&R cost savings must be annualized over the period of analysis.

One of the most important aspects of estimating these cost savings is the determination of the parameter of water use that is used in timing and sizing capital facilities. In many cases, the following parameters are used for sizing each of the types of facilities listed below:

1. maximum-day use (including losses) for water treatment, finished water storage and transmission facilities

2. average-day water use for large raw storage facilities

3. average day sewer contribution for wastewater treatment and transmission facilities (often infiltration and in-flow are added) -- some elements of wastewater treatment are related to total loadings of biochemical oxygen demand or solids and will not be affected by changes in water use. The timing of some investments may be primarily determined by the desire to upgrade effluent quality. Total use may only affect the size of these capital investments, not their timing.

In some cases, it will be unclear whether a small incremental use reduction will be considered in the planning process. Of course, if it is not, the investment program will be unaffected. Benefits will still be present in the form of increased quality of service (system reliability, effluent quality, etc.). For an efficiently-operated utility, capital improvements will be made up to the point where the incremental benefit of the last improvement (in terms of quality of service) is equal to the incremental cost.

Therefore, for changes in use that are small relative to total use, the potential (but possibly unrealized) cost saving can provide a good approximation of the benefits of the improved quality. The utility's decision to take the benefits in the form of increased quality rather than reduced costs indicates that the advantageous effects of improved quality are worth at least as much as the cost of saving.

In determining the extent of the size reduction or of the delay in construction of a capital facility that is to be identified as an advantageous effect of conservation, attention must be given to the implied design practice of the utility. Where facilities are designed to be adequate for a specified design drought, more severe droughts can be accommodated by emergency water use reduction measures. The implementation of water conservation may reduce the future effectiveness of such emergency measures, requiring a larger margin of safety between supply and expected demand, if system reliability is to be unaffected. Long-run incremental cost functions should incorporate these considerations, where necessary.

Many times capital improvement programs are not available or are only available for the next several years. In these cases, judgment must be exercised to implement a reasonable capital improvement program based on the current practice.

Chapter VIII

WATER CONSERVATION PLAN DEVELOPMENT

Evaluation of water conservation measures results in a list of eligible measures, with all advantageous and disadvantageous effects identified and measured or described for each measure. In order to integrate water conservation measures into the supply plan, individual measures must be combined to form water conservation proposals. The proposals become the water conservation elements of the plan. Water conservation proposals should be developed to enhance features of the community's water supply plan. The following sections describe the development of water conservation proposals suitable for integration into the various alternative water supply plans.

PROPOSAL DEVELOPMENT PRINCIPLES

ELIGIBLE WATER CONSERVATION MEASURES

The water conservation measures to be considered in the development of water conservation proposals are those found eligible according to the evaluations described in Chapters IV, V, and VII.

MERIT ORDER

Because of the possibility of interactions among individual water conservation measures, it is helpful to introduce individual measures into each alternative water conservation proposal in merit order -- the "best" measure is included first, followed by the next "best," etc. The definition of "merit" depends upon the goals described in Chapter II and on the results of technical, social, and financial analyses (described in Chapters IV, V and VII).

INTERACTIONS

Water conservation measures can be expected to exhibit interactions with respect to both effectiveness and implementation costs. In some cases, interactions may also appear for other advantageous and disadvantageous effects, including environmental effects.

Interactions with respect to effectiveness appear when two different conservation measures affect that same water use or water use behavior. For example, restrictions on lawn irrigation reduce the amount of water use for this purpose, but changes in the summer price of water also affect the same water use. The effectiveness of both measures, implemented together, would be strictly less than the sum of the effectiveness of the two measures implemented individually. In fact, whenever metering and pricing measures are implemented in conjunction with other water conservation measures, interactions can be expected.

Interactions with respect to implementation costs appear when two measures share common implementation characteristics. Typically, the implementation of two measures at the same time results in costs borne by the water utility

and/or public agencies that are less than the sum of costs of implementing the measures individually. In most cases, joint implementation can be expected to reduce aggregate implementation costs. This interaction is most striking in the case of educational efforts.

NET BENEFICIAL EFFECTS

As individual water conservation measures are added to trial water conservation proposals, the net beneficial effect of adding the additional measure must be determined. In every case, the net beneficial effect is defined with respect to the goal. The net beneficial effect is found by determining the excess of all advantageous effects on the plan objective over all disadvantageous effects on the plan objective before adding the additional measure, then determining the same excess after adding the additional measure, and finally noting whether the second amount (with the additional measure) is greater (increase in net beneficial effect) than the first.

DEVELOPMENT OF ALTERNATIVE PROPOSALS

The community has several options in selecting and sequencing various water conservation measures. Selection depends on the following factors:

1. goals established for the water conservation plan
2. relative social acceptability of each water conservation measure found to be acceptable
3. technical feasibility of each water conservation measure
4. cost effectiveness of each water conservation measure

An obvious approach could be to first select and evaluate the measures that yield the greatest cost savings. However, other measures may better fit the water conservation goals of the community or may be more socially acceptable. In essence, the measures are evaluated by relative feasibility. The most feasible (with regard to goals, social acceptability, technical feasibility and cost effectiveness) would be incorporated into the water conservation plan first. Other measures may be categorized as "potentially feasible" and may be considered for future application (increased severity of supply problem, expected change in social acceptability, etc.).

Whenever one of the final water supply conservation plans includes potentially feasible or potentially acceptable measures, a second plan should be developed on the same criteria, except that potentially feasible and potentially acceptable measures would be excluded from the list of eligible measures. Both plans should be presented for comparison, so that the consequences of not implementing the potentially feasible or potentially acceptable measures can be contrasted with the difficulty of removing impediments.

SUPPLY RELIABILITY CONSIDERATION

The advantages of water conservation result largely from possible reductions in supply capability, when system reliability is held constant. If the overall reliability of the supply system is altered by the implementation of water conservation practices, additional disadvantageous or advantageous effects are created. The need to identify and measure these additional

effects can be avoided by holding system reliability constant throughout the analysis. Following development of alternative water conservation proposals, this assumption should be tested by determining the performance of each alternative supply plan, with and without the water conservation element, for the last year in the planning period, assuming drought conditions. Supply plans with water conservation will differ from those without this element in having down-sized or delayed construction schedules, as well as lower levels of water use. Where water deficits appear for drought conditions, emergency water use reduction measures (not already incorporated in the water conservation proposals) are required. The extent and severity of measures required for supply plans that incorporate conservation should not exceed those for the corresponding supply plans without conservation.

DOCUMENTATION OF WATER SUPPLY CONSERVATION PLANS

The procedures described in the previous sections will result in one or more water conservation proposals that can be integrated with water supply plans to form water supply conservation plans. Wherever proposals include potentially feasible or potentially acceptable measures, alternative plans will be developed that exclude these measures. The documentation of each water supply conservation plan should include the following items:

1. The full list of applicable water conservation measures considered, showing which measures were excluded as not technically feasible, which were excluded as not socially acceptable and which were excluded in the process of plan formulation

2. A list of water conservation measures considered not applicable because they are already implemented or because definite commitments have been made to implement them within the planning area

3. A list of each water conservation measure in the proposal, with a full description for each measure, an indication of the agency or other entity responsible for its implementation and a summary of the implementation plan, including estimated coverage and duration

4. Aggregate implementation cost for the water conservation proposal, expressed as annualized cost; implementation cost for the proposal identified by responsible party (utility, residential water users, etc.)

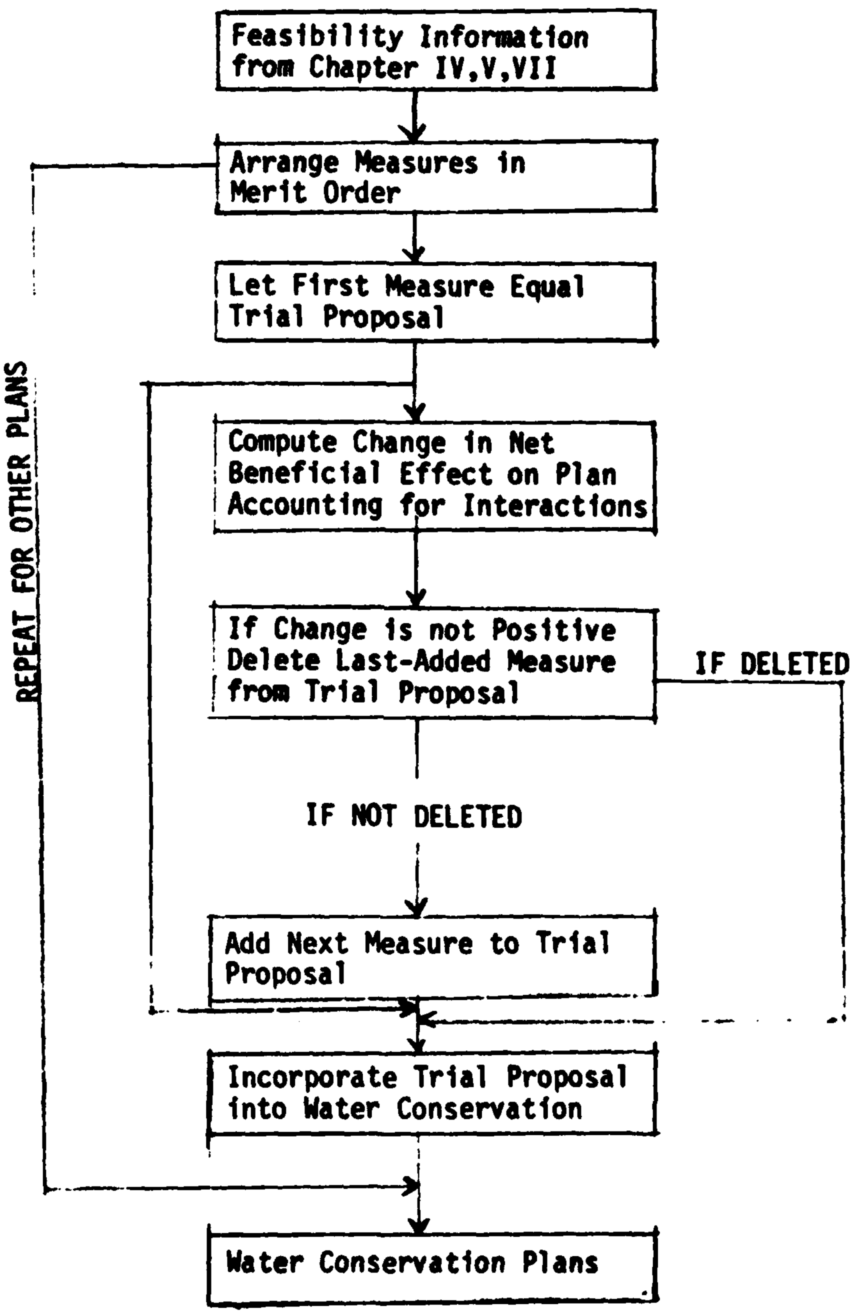
5. Aggregate effectiveness for the water conservation proposal, shown separately with respect to average-day water use, maximum-day water use, and average-day sewer contribution; shown for selected times throughout the planning period

6. A description of the water supply plan, without water conservation

7. A description of the water supply conservation plan, incorporating the water conservation proposal

Figure VIII-1

Development of Water Conservation
Planning Procedure



APPENDIX A

MUNICIPAL AND INDUSTRIAL NEEDS (MAIN II)

The tool used to make projections for Eau Claire, Wisconsin, is a computerized forecasting system called MAIN II. The MAIN II System is a tool for estimating and forecasting municipal water requirements. MAIN is an acronym for Municipal And Industrial Needs. This system is designed for the use of urban planners, water resource planners, and water utilities. It improves the ability to develop sound and realistic plans involving the supply and allocation of municipally-supplied water. The version of MAIN II used here is the one modified by the U.S. Army Corps of Engineers, St. Paul District, at the request of the Wisconsin Department of Natural Resources in 1984.

Water requirements for a study are estimated separately for the residential, commercial/institutional, industrial, and public/unaccounted sectors. Within these sectors, requirements are further estimated for individual categories of water users, such as metered-seweredd residences, flat rate-sewered residences, commercial establishments, institutions, three-digit Standard Industrial Classification (S.I.C.) manufacturing categories or individual manufacturers. Estimates are made of mean-annual, maximum-day, and peak-hour water-use requirements. These features not only assure greatly improved information about the nature of future water demands, but they also permit the final estimate to be responsive to changes in the mix of water-using activities that occur in the growth of metropolitan areas. Water requirements can be estimated for current and projection years.

Research performed by the Johns Hopkins University, as well as data gathered by the Bureau of the Census, American Water Works Association, Hittman Associates, Inc., and other groups, has resulted in a series of mathematical models of water requirements that permit in the MAIN II System to accurately estimate water demands in the various categories as a function of specified water-use parameters. These water-use parameters include factors such as home value, persons per household, retail floor space, and industrial employment in each three-digit (S.I.C.) category. Users of the MAIN II System can provide detailed local data when these data are easily obtainable, and the users can rely on data collected and condensed from national samples when local data are difficult to obtain.

Forecasts of water requirements result from projection the value of the water-use parameters by a variety of methods. The MAIN II System users can tailor the operation of the system to a specific community and select a separate projection method for each category.

The MAIN II Users Manual describes the MAIN II System in sufficient detail to permit its application to a specific local forecasting effort. The MAIN II System computer program and the Library of Water Usage Coefficient are also described in detail. Examples of data preparation and output reports are given. The manual also contains data regarding required computer

characteristics and the specifications of the MAIN II System computer program and library magnetic tapes. The MAIN II System has been designed and the user's manual has been written so that the user needs little training or experience with computers.

A copy of the MAIN II Model User's manual can be obtained from Wisconsin Department of Natural Resources.

APPENDIX B

FISCAL PLANNING AND WATER CONSERVATION IN MADISON, WISCONSIN*

The water-conservation program in Madison, Wisconsin, differs from most other conservation programs. It was not the result of a shortage but rather the result of long-range fiscal planning. Analyses showed that postponing certain electrical demand costs associated with pumping could save customers substantial costs and cause only minor inconvenience.

Controlling Factors for System Capacity - Madison's problem was that total system capacity was dictated by a few hot, dry, summer days with peak pumpages. Over the last several years before the program peak-day pumpage had been about 51 mgd whereas the daily average was only 30 mgd. Since this trend had been increasing, new wells and reservoirs were needed to keep ahead of the increasing demand (figure 1). Each additional 3-mgd increase in system capacity meant an additional $750,000 in construction costs, plus several hundred staff hours. Over a life of each pumping facility, this cost translated to $62,000 per year.

In addition, even a pumping unit used only a few hours a month to meet these peaks, the electric power demand would have to be paid for the entire month. For some units, this monthly cost amounted to $700.

An analysis of maximum day usage revealed that the 6:00 p.m. lawn-sprinkling load was a key factor (figure 2).

*Larry E. Deibert, "Fiscal Planning and Water Conservation in Madison, WI," AWWA Journal/Management and Operations, January 1978.

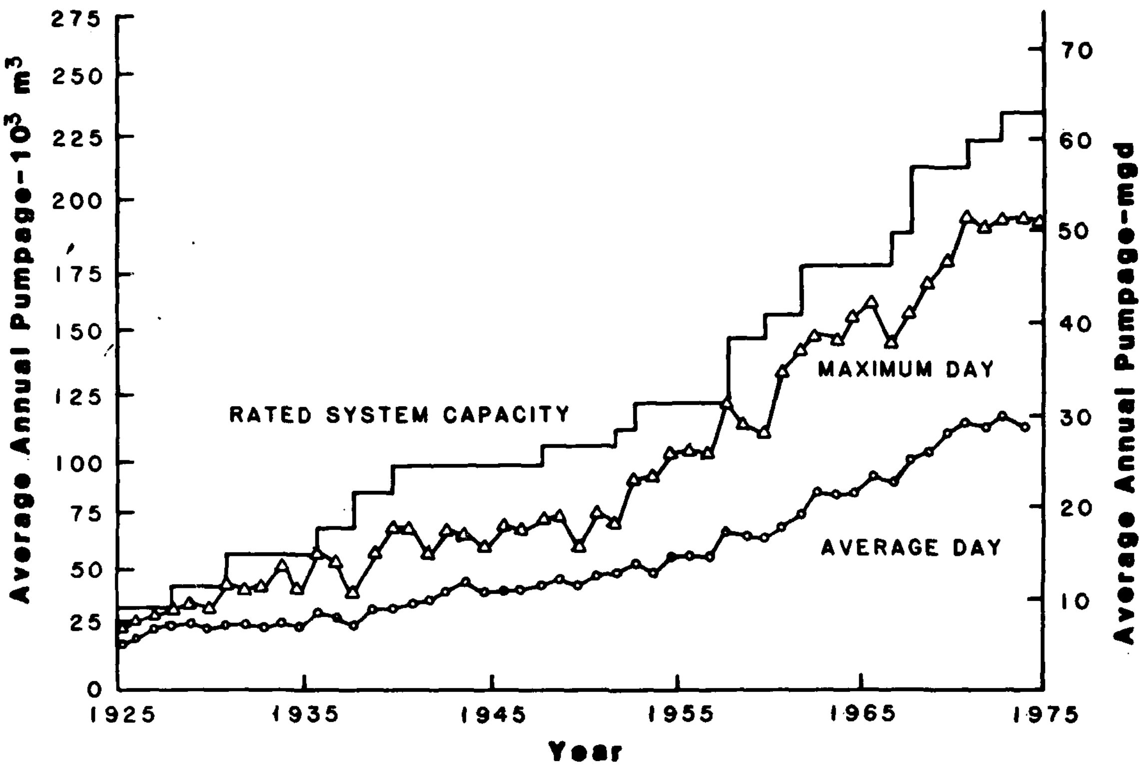


Figure 1. Growth in Peak-Day Usage for Madison, Wisconsin, Water Utility

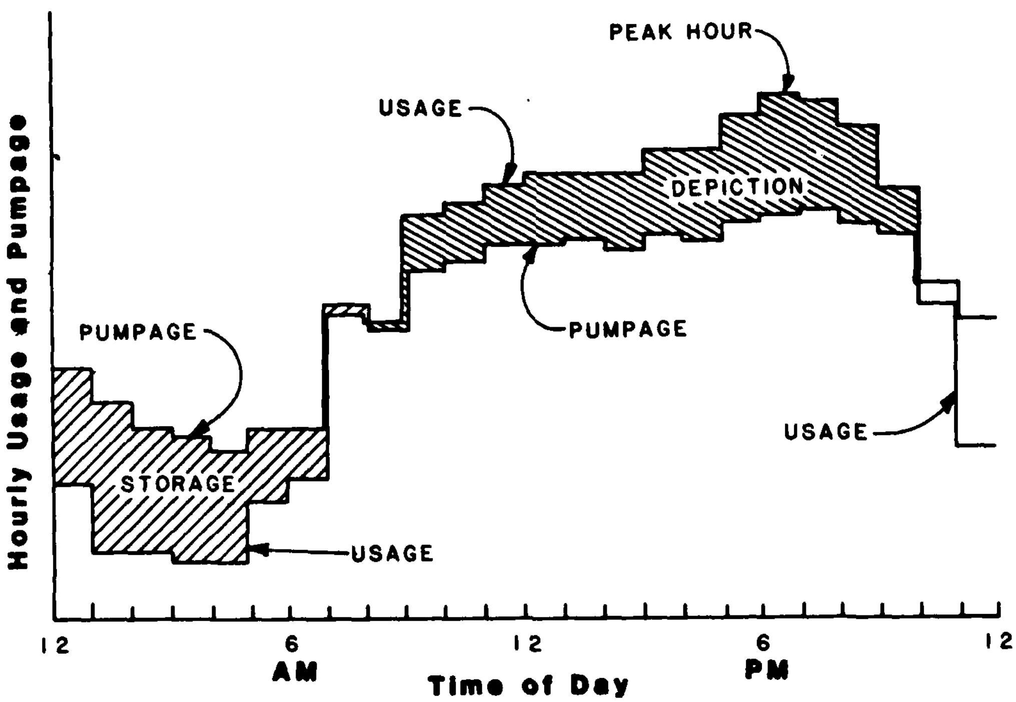


Figure 2. Analysis of Maximum Day Usage of Madison, Wisconsin, Water Utility

Since each block of 3,400 lawn sprinklers could add $62,000 in annual facility costs, the solution was to minimize sprinkling or to reduce its effects on water demand.

Conservation Program Initiated in 1975 - The water conservation program was initiated to shift the sprinkling load to off-peak hours (from 6:00 p.m. to after 8:00 p.m.). Not only would customers save money but also the valuable natural resources - water and fossil fuels - needed to generate the electricity for pumping water. The program goal was not to restrict water use, but to convince customers that they could use less water.

To meet this goal, a $40,000 program (including two additional staff persons) was introduced. The following specific sprinkling tips were communicated:

1. Adjust the sprinkler or soaker hose to only water the lawn. Sidewalks, driveways, and gutters will not grow a thing.

2. Give the lawn only the water it needs; 2.5 cm (1 in.) per week at one time is sufficient.

3. Avoid watering when it is windy or in the heat of the day. Evaporation robs both the customer and the lawn.

4. Above all, and most important, if the sprinkling is necessary, do it before 10:00 a.m. or after 8:00 p.m. when it would have less impact on the water system.

Various Publicity Techniques - These lawn sprinkling tips were communicated in many different ways, without the aid of paid consultants. Local radio and television staff and two college journalist students provided valuable free assistance.

Aisle display - Two different aisle displays (panels with pictures and graphs) were exhibited at 16 locations for roughly 2 weeks at each site. One display dealt with Madison's supply system and the reasons for the excess capacity. The other dealt with sprinkling.

School Talk - A slide, a speaker, and film presentation in the elementary schools involved youngsters in water conservation and encouraged them to carry the message home to their parents. The two films were Water Follies (A Soak Opera) and Miss Drip, prepared by the Denver Board of Water Commissioners and Washington Suburban Sanitation Commission, respectively.

Hose Tags - Water meter readers hung approximately 30,000 blue weather-resistant hose tags with sprinkling tips on accessible outside faucets. These tags served as reminders to residents.

Bus Posters - City buses also spread the conservation message. One hundred posters were displayed inside the buses; plus a dozen large posters were displayed on the rear of buses.

Billboards - Six billboards also drew attention to the campaign.

Radio and television - Extensive use was made of the area radio and television stations. Four different 30-second television spots played on the three area stations during a 10-week period. Six different 30-second radio spots aired an average of three times daily on foru stations during the 10-week period. These spots were also played as public servic announcements by all eight area radio stations.

Brochures - A 14-page brochure addressed indoor and outdoor use of water. These brochures were distributed to new customers, and they were made available on request for special school programs.

Results of the Conservation Program - To check the results of the program, a survey was sent to 1,000 randomly-selected customers prior to the public information campaign. Respondents were asked to fill out a second survey at the end of the campaign. The initial survey assessed customers' water-use habits. The follow-up survey assessed changes brought about by the information campaign and determined the most effective means of communication.

The initial survey revealed that 46.6 percent of the respondents watered between 4:00 and 7:00 p.m., but only 38.9 percent watered after 7:00 p.m. and before 8:00 a.m. The follow-up survey showed a shift in these categories to 18.2 percent and 68.0 percent, respectively. In the follow-up survey, 78 percent correctly answered that the utility requested no lawn sprinkling until after 8:00 p.m. Those results showed the utility's success in reaching a substantial majority of customers.

As figure 3 illustrates, the primary objective of shifting the peak-hour load was accomplished. The program influenced many customers to water after 8:00 p.m. A decrease in water use during the early afternoon was a secondary result of the program.

Because of the lessening of the formerly heavy demand during the supper hour, the existing system capacity could easilty meet the existing and near-future demands. With continued program success, additional costs for increased system capacity to meet peak demands can be postponed.

Madison's water conservation program shows that customers willingly participate in a conservation program that involves minimum inconvenience but can account for substantial savings.

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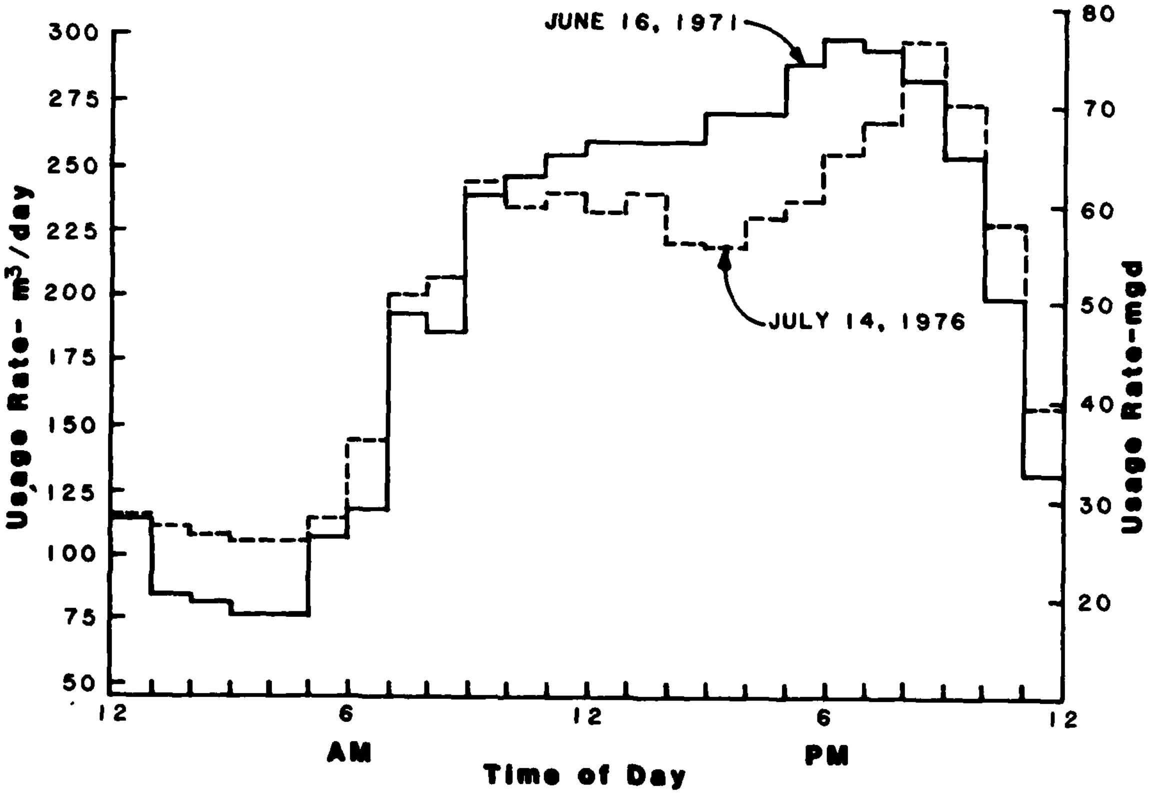

Figure 3. Peak-Day Hourly Usage for Madison, Wisconsin, Water Utility

APPENDIX C

WATER CONSERVATION PLAN FOR THE

CITY OF EAU CLAIRE, WISCONSIN

ACKNOWLEDGEMENTS

The Water Conservation Plan for the City of Eau Claire is prepared by the U.S. Army Corps of Engineers, the City of Eau Claire, and the Wisconsin Department of Natural Resources under the authority of the Water Resources Development Act of 1974, Public Law 93-251. The following people were the principal study team personnel responsible for preparing this document:

City of Eau Claire Water Conservation Committee

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The City Assessor, Mr. Jerry Tubbs, and the City Planning Director, Larry Timm, were very helpful in making their staff and data available for preparation of this report.

WATER CONSERVATION PLAN
EAU CLAIRE, WISCONSIN

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I. INTRODUCTION

The purpose of this study is a water supply conservation plan that would be an example for other communities in the State that might wish to undertake similar duties using the Wisconsin Municipal Water Conservation Procedures Manual.

Eau Claire was selected by the Wisconsin Department of Natural Resources for development of the model water conservation plan for these reasons:

1. It has a population size within the 30,000 to 60,000 range deemed best for the purpose of this study.

2. Its score in the Statewide Municipal Water Conservation Need Index, an indicator of communities most likely to benefit from water conservation efforts, is high.

3. Its utility serves a mix of residential, industrial and commercial water customers.

4. Service to the entire community is by the same public water supplier.

5. The utility is not under DNR order to upgrade its wastewater treatment facilities.

6. Groundwater is the water supply source.

7. It is located near St. Paul District Corps office and a DNR District headquarters.

8. Disaggregated water use data was available.

9. Local officials were willing to cooperate with the DNR and Corps of Engineers in the study.

Eau Claire's Statewide Water Supply Conservation Need Index score was based on information derived from data submitted to the DNR and the Wisconsin Public Service Commission in 1980. The data showed relatively high residential water consumption (58.8 gallons per capita per day), a relatively high percentage of unaccounted-for pumped water (17.04 percent) and a high rate of population growth (15.5 percent between 1970 and 1980). Another factor considered in Index scoring, "potential supply problems," was not considered a problem in Eau Claire. Between the time the 1980 data were submitted and the time this report was prepared, Eau Claire initiated metering and leak detection steps that reduced unaccounted-for water pumpage to below 10 percent. Rate increases in residential water consumption resulted. Per capita consumption is now down to 52 gallons per day. Based on an assumed 1982 population of 52,500 (1980 population being 51,509), this represents an 11.5 percent reduction.

Because of these water supply management measures undertaken by the city and because of the conservation effect pricing had on the community -- actions all

effected prior to this report's completion -- the water conservation plan recommended for Eau Claire in this manual does not reflect the full potential benefits to be realized by most communities in applying such a plan. Eau Claire is, however, evidence that conservation measures bring results.

The goals for the City of Eau Claire were assumed to be the following:

1. Reduce the amount of unaccounted-for water pumped by the utility.

2. Determine whether there were means of reduce the relatively high per capita residential consumption.

Because of activities undertaken by the Eau Claire water utility, unaccounted-for water pumpage and per capita water consumption decreased. These reductions were accomplished after collection of State data indicating the desirability of water conservation for Eau Claire but prior to initiation of this study.

The base year for the Eau Claire study is 1982. Eau Claire is at 44°49' latitude and 91°31' longitude. Its 1982 population was 51,509.

II. MUNICIPAL WATER REQUIREMENTS

Municipal water requirements and the MAIN II estimates for Eau Claire are shown in Tables II.1 and II.2.

Table II.1
Municipal Water Requirements for the City of Eau Claire - 1982

Sector	City Data (annual average, gallons per day)	MAIN II Calculation (annual average, gallons per day)	Difference from Actual
Residential	2,614,358	2,731,678	+4.3%
Commercial	1,640,175	1,807,892	+9.3%
Industrial	2,986,816	3,210,037	+7.0%
Public & Loss	1,368,909	1,368,909	0% (actual was used in model)
TOTAL	8,610,258	9,118,515	+5.6%

Table II.2
Municipal Water Requirements for the City of Eau Claire, Wisconsin
for the Year 1982
Analyzed by MAIN System

Current Residential Water Requirements in Gallons Per Day

Annual Average	Maximum Daily	Peak Hourly
2,731,678	6,040,153	17,250,437

Requirements by Type - Annual Average

Type	No. of Units	Domestic (Gallons per day)	Sprinkling (Gallons per day)	Total (Gallons per day)
Total Metered and Sewered	15,172	2,487,740	243,937	2,731,678

Summer Evapotranspiration (inches) = 13.75
Summer Precipitation (inches) = 10.50
Max. Day Evapotranspiration (inches) = 0.29

Residential

Residential data needed for the MAIN II model were obtained from the city offices. The aggregate number of housing units was obtained as well as the number of units in each housing type and in price per unit categories. Not all residential units are listed in the residential sector -- many apartment units are considered commercial by the utility, and this convention was followed when setting up the MAIN data base.

The breakdowns of residential housing units are in Tables I.3, I.4, and I.5.

Table II.3
Housing Calculations

Housing Units	Amount
Single-family residences	11,575
Duplex units	3,002
Condominium units	116
Apartment units	2,570*
Triplex and miscellaneous units	2,409
Total housing units	19,672

* 4,500 of the city's apartments are treated in the commercial sector.

Table II.4

MU:CIPAL WATER REQUIREMENTS FOR THE CITY OF EAU CLAIRE, WISCONSIN FOR THE YEAR 1982

ANALYZED BY MAIN SYSTEM

CURRENT RESIDENTIAL WATER REQUIREMENTS BY CATEGORY
METERED AND SEWERED AREAS
AVERAGE ANNUAL

'ALUE RANGE ($)	NO. OF UNITS	DOMESTIC	SPRINKLING	TOTAL	MAX DAY	PEAK HOUR
5000. - 10000.	240.	30556.	433.	30989.	43052.	166995.
10001. - 20000.	2537.	346709.	12511.	359220.	598563.	2054659.
20001. - 25499.	1697.	248300.	13396.	261696.	501537.	1578398.
25500. - 30000.	1558.	237668.	16404.	254073.	517399.	1563966.
30001. - 40000.	3343.	540166.	49284.	589450.	1285180.	3708771.
40001. - 49999.	2790.	485573.	59214.	544787.	1271243.	3495958.
51000. - 60000.	1512.	282931.	37286.	320217.	812518.	2143857.
60001. - 70000.	786.	156383.	24374.	180757.	475315.	1221234.
70001. - 80000.	343.	72517.	13089.	85606.	231529.	581555.
80001. - 90000.	161.	36045.	7366.	43411.	119907.	295627.
90001. - 99999.	93.	21980.	4167.	26147.	77183.	186740.
100000. - 125000.	112.	28912.	6413.	35325.	106727.	252677.
TOTAL	15172.	2487740.	243937.	2731678.	6040153.	17250437.

Table II.5
Metered Sewered Housing

Value Range ($1,000's)	Number of Units	Housing Units Per Acre*	Persons Per Housing Unit
5-10	240	8.0	2.4
10-20	2,537	8.0	2.4
20-25	1,697	7.0	2.4
25-30	15,580	7.0	2.4
30-40	3,343	7.0	2.7
40-50	2,790	7.0	2.9
50-60	1,512	6.0	3.05
60-70	786	6.0	3.1
70-80	343	6.0	3.2
80-90	161	6.0	3.5
90-100	93	5.0	3.8
100-125	112	5.0	3.8

* Housing units per acre have been estimated for the purpose of adjusting the model's values toward actual aggregate annual use.

Commercial

Data on commercial units were also obtained from the city. MAIN II is designed to accept input on the number of units that correlate with each commercial category and then to apply predetermined use/unit parameters to these figures to estimate actual use. The use/unit parameters may be supplied by the planner if the MAIN II parameters do not accurately reflect local use. For the Eau Claire study, use parameters were calculated from local data for hospitals, YMCA-YWCA facilities, and apartments. The results of the calculations are compared with the MAIN II estimates in Table II.6.

Table II.6
Commercial Units

Apartments:
- 4,500 units in the commercial sector
- 445,950 gpd (gallons per day) actual use (from water utility sources)
- 99.067 average annual gpd use/unit

YMCA-YWCA Facilities:

	Actual	MAIN Estimate
Average gallons daily	13,458.8	311,322.0
Members	9,349	9,349
Use coefficient	1.440	33.300

Hospitals

	Actual	MAIN Estimate
Sacred Heart	111,537.5 average gpd	
Luther	105,928.3 average gpd	
Total beds: 663	217,446 average gpd	229,209.164
Use coefficient*	328.003	345.715

* Gallons per employee per day.

The original MAIN II run (with no parameter changes) estimated current commercial use at greater than a 10-percent difference. To find where the estimates deviated the most, the commercial users estimated to have the greatest overall use were checked. Retail space, office space, and motels accounted for a large portion of commercial use, but verifying use for these commercial users would have been difficult because of the large number of individual entities included in these categories. Hospotals and YMCA, on the other hand, could easily be checked because the total number of units was shared by only one or two establishments. Since this was true, total units (supplied by the city) also applied to units in the establishment, and only a few water-billing accounts had to be found in computer printouts (supplied by the utility) to calculate actual use for the establishment during the past year. Estimated hospotal use turned out to be very close to actual use (off by about 5 percent), but estimated use per member for the YMCA was off by a factor of 30. This is a case where the local facility is atypical and therefore not well estimated by the generalized parameter in MAIN II. By changing this parameter, the total commercial estimate made by MAIN II fell within the error range of 10 percent.

Commercial apartments in a category that was not included in the original MAIN II. It has been treated as a user-added category, and the unit/use parameters were calculated from local data. Total number of units was calculated, total use for those accounts was established, and the use parameter was thus determined. There was no MAIN II parameter with which to compare the Eau Claire figure; however, the figure (99.067 gpd) is almost exactly the same as a figure independently calculated in a parallel study in the Fargo-Moorhead region (approximately 104 gpd, figured for occupied units only, with a 5 percent vacancy rate). Commercial use estimates are shown in Table II.7.

Table II.7

MUNICIPAL WATER REQUIREMENTS FOR THE CITY OF EAU CLAIRE, WISCONSIN FOR THE YEAR 1982

ANALYZED BY. MAIN SYSTEM

TOTAL COMMERCIAL REQUIREMENTS IN GALLONS PER DAY

ANNUAL AVERAGE	MAXIMUM DAILY	PEAK HOURLY
1807892.	.3173021.	8441911.

WATER REQUIREMENTS BY TYPE OF COMMERCIAL ESTABLISHMENT

TYPE	UNITS	NUMBER OF UNITS	MULT FACTOR	ADD FACTOR	ANNUAL AVERAGE	MAXIMUM DAILY	PEAK HOURLY
					(GALLONS	PER	DAY)
HOTELS	SQ. FT.	106015.	1.000	0.000	27140.	31168.	45904.
MOTELS	SQ. FT.	512874.	1.000	0.000	114884.	236435.	794955.
BARBER SHOPS	BARBER CHAIR	50.	1.000	0.000	2730.	4015.	19450.
BEAUTY SHOPS	STATION	165.	1.000	0.000	44385.	54120.	176550.
RESTAURANTS	SEAT	5500.	1.000	0.000	133100.	458700.	918500.
DRIVE-IN REST-NT	CAR SPACE	400.	1.000	0.000	43600.	57600.	218800.
NIGHT CLUBS	PERSON SERVED	400.	1.000	0.000	532.	532.	532.
HOSPITALS	BED	663.	1.000	0.000	217466.	365313.	604656.
NURSING HOMES	BED	487.	1.000	0.000	64771.	71102.	206488.
MEDICAL OFFICES	SQ. FT.	103842.	1.000	0.000	64174.	172378.	516095.
LAUNDRY	SQ. FT.	23042.	1.000	0.000	5830.	7512.	36176.
LAUNDROMATS	SQ. FT.	17813.	1.000	0.000	38654.	84434.	27966.
RETAIL SPACE	SALES SQ. FT.	3205701.	1.000	0.000	339804.	493678.	868745.
BUS-RAIL DEPOTS	SQ. FT.	2160.	1.000	0.000	7193.	14040.	54000.
CAR WASHES	INSIDE SQ. FT.	13548.	1.000	0.000	64759.	139544.	426762.
CHURCHES	MEMBER	30000.	1.000	0.000	4140.	25860.	141000.
GOLF-SWIM CLUBS	MEMBER	1000.	1.000	0.000	31000.	22200.	22200.
BOWLING ALLEYS	ALLEY	74.	1.000	0.000	9842.	9842.	9842.
NEW OFFICE BLDG.	SQ. FT.	412374.	1.000	0.000	38351.	71341.	214847.
OLD OFFICE BLDG.	SQ. FT.	395590.	1.000	0.000	56174.	32043.	140039.
JAIL & PRISONS	PERSON	80.	1.000	0.000	10640.	10640.	10640.
THEATERS	SEAT	3512.	1.000	0.000	11695.	11695.	11695.
YMCA-YWCA FACIL.	PERSON	9349.	1.000	0.000	13547.	311322.	311322.
SERVICE STATIONS	INSIDE SQ. FT.	70438.	1.000	0.000	17680.	41558.	2210797.
APARTMENTS	UNITS	4500.	1.000	0.000	445802.	445950.	445950.

Industrial

All parameters for estimating industrial use in Eau Claire were calculated using local data. Parameters in the industrial sector are in terms of gallons per day. Employment figures for Eau Claire industrial establishments were taken from the 1983 Manufacturers and Processors Directory. Water use figures were calculated from water utility billing files. The MAIN II estimate differs from the actual 1982 use by 6.9 percent. This difference is not zero because the most recent four quarters of billing were used to determine an industry's use, and this period may or may not have corresponded to the calendar year of 1982 used for the total. Fluctuations of use in the recent past, therefore, account for the difference.

Table II.8

MUNICIPAL WATER REQUIREMENTS FOR THE CITY OF EAU CLAIRE, WISCONSIN FOR THE YEAR 1982

ANALYZED BY MAIN SYSTEM

TOTAL INDUSTRIAL WATER REQUIREMENTS IN GALLONS PER DAY

ANNUAL AVERAGE	MAXIMUM DAY	PEAK HOURLY
3210037	3530819	3687998

REQUIREMENTS BY TYPE OF INDUSTRY

ID#	INDUSTRY	NUMBER OF EMPLOYEE	PRODCT.	EFFIC.	ANNUAL AVERAGE	MAXIMUM DAY	PEAK HOUR	AVE. ANNUAL EMPLOYEE USE COEFFS.*
201	ARMOUR	225	1.000	1.000	70,344	70,344	93,780	312.64
202	WISC BEEF	300	1.000	1.000	30,655	30,655	128,751	102.18
203	LAND 'O LAKES	100	1.000	1.000	233,096	233,096	233,096	230.96
204	MARIGOLD	30	1.000	1.000	10,813	10,813	21,626	360.43
205	TOLONA PIZZA	26	1.000	1.000	2,050	2,050	2,050	109.17
206	HOLSUM BAKERS	95	1.000	1.000	11,268	11,268	11,268	118.61
207	COCA COLA	40	1.000	1.000	1,336	1,336	1,336	33.40
208	WALTER BREW	30	1.000	1.000	49,668	49,668	74,502	1,655.60
209	CAREER DEVELOPMENT	227	1.000	1.000	2,551	2,551	2,551	11.24
210	POPE & TALBOT	700	1.000	1.000	1,699,999	1,699,999	1,699,999	1,970.31
211	SHEDD BROWN	100	1.000	1.000	15,787	15,787	15,787	157.87
212	JOHNSON LITHO	55	1.000	1.000	4,190	4,190	4,190	76.18
213	JENNICO	6	1.000	1.000	451	451	451	75.09
214	UNIROYAL	1500	1.000	1.000	1,357,395	1,357,395	1,357,395	904.93
215	AMERICAN MA%904ALS	100	1.000	1.000	344	344	344	3.44
216	AMERICAN PRESTRESS	30	1.000	1.000	1,890	1,890	1,890	63.01
217	FEHR CONCRETE	90	1.000	1.000	5,288	5,288	5,288	58.75
218	MAX PHILLIPS	30	1.000	1.000	2,562	2,562	2,562	85.40
219	PHOENIX STEEL	200	1.000	1.000	13,610	13,610	13,610	68.05
220	GOULD	111	1.000	1.000	19,617	19,617	19,617	176.73
221	N.W. MOTOR	40	1.000	1.000	2,079	2,079	2,079	51.97
222	MCDONOUGH MFG	26	1.000	1.000	385	385	385	14.81
223	HUTCHENS INDSTY	21	1.000	1.000	277	277	277	13.71
224	MEMOREX	250	1.000	1.000	205,165	205,165	205,165	820.66

* THIS COLOUMN IS NOT PART OF THE MAIN II OUTPUT, BUT IS FOR COMPARISON ONLY.

It should be noted that peak-hour and maximum-day use figures in the industrial sector are the same as the average-annual use figures. This is an assumption made in the original version of MAIN II. Maximum-day and peak-hour use parameters can be supplied by the planner, however, if adequate data to support changes in the parameters can be determined for particular industries.

Public and Loss

Estimates for public use and system loss do not vary from the actual use figures given by the water utility, since those figures were used in the mode. Public use is currently being treated in aggregate. This use could be

disaggregated if particular users, such as the airport or university, appear to have distinctive use or growth patterns that differ from other public users. If such differences are evident, disaggregating use into public categories would improve confidence in projections or estimates of maximum-day or peak-hour use. This, too, should receive attention when further project priorities are discussed.

Table II.9
Calculation of System Loss

1982	Amount
Total gallons pumped	3,340,530,000
Total gallons paid	-3,027,261,000
Loss in system (annual total)	313,269,000
Loss in system (average daily)	857,684

Loss in the system for 1982 was 9.4 percent. Total system loss in Eau Claire has been as high as 17 percent in recent years (1980).

With the data and parameter refinements mentioned in this section, the MAIN II estimate falls within the accepted level of 10-percent error. The overall municipal estimate is only 2.5 percent over actual, since estimates in the commercial and industrial sectors are higher than actual use, but the estimate in the residential sector is lower than actual use, and cancelling of errors in the aggregate occurs.

Table II.10
Municipal Water Requirements for the City of Eau Claire, Wisconsin
For the Year 1982
Analyzed by Main System

Total Public Services and Distribution Loss Requirements in Gallons Per Day

Annual Average	Maximum Daily	Peak Hourly
1,368,909.	1,368,909.	1,368,909.

Requirements by Type of Public Service and Distribution Loss Usage in Gallons Per Day

Type	Annual Average	Maximum Daily	Peak Hourly
Distribution Losses	857684.	857684.	857684.
Public Services	511225.	511225.	511225.

Table II.11
Summary of Municipal Water Requirements for City of Eau Claire, Wisconsin

Estimated Water Requirements for Year 1982
(all values in gallons per day)

Type	Annual Average	Maximum Daily	Peak Hourly
Municipal	9118515.	12426991.	23637275.
Residential	2731678.	60401353.	17250437.
Commercial	1807892.	3173021.	8441911.
Industrial	3210037.	3530819.	3687998.
Public Service	511225.	511225.	51125.
Distribution Loss	857624.	857684.	857684.

III. SOCIAL ACCEPTABILITY

The successful implementation of a water conservation plan requires that the plan be socially as well as technically feasible. A social acceptability survey, like that recommended in the Water Conservation Procedures Manual, was carried out for Eau Claire.

The following discussion of attitudes toward water conservation in Eau Claire summarizes (1) a mailed questionnaire completed by 101 citizens (50-percent response rate, from a random sample) and (2) interviews with nine community leaders. The discussion notes general themes that affect water conservation, and it discusses seven broad categories of possible conservation measures in more detail.

Several identifiable themes are present in the terminology and logic of the community leaders' discussions. These themes also help interpret some of the responses in the attitudinal survey.

1. There is no water supply problem in Eau Claire - at most, there <u>might</u> be a water quality problem. If anything, they have problems because of excess capacity (i.e., delivery capacity causing high fixed costs).

2. It was perceived by those interviewed in Eau Claire that conservation on a large scale simply leads to rate increases. Those increases may change the equity bases for the various consumer group.

3. Cost effectiveness, for whatever measure and for whichever group or organization is involved, is a very important principle to this (self-defined) conservative community. Water conservation will not be acceptable as a higher value in itself, unless it is cost effective.

4. Governmental actions should be limited rather than expanded, unless the public welfare unequivocally indicates a need.

5. There is some known distribution loss in Eau Claire. These losses are presently being evaluated by the Public Works Department.

The water conservation measures that were evaluated for Eau Claire were as follows:

1. Reuse
2. Education
3. Building codes
4. Retrofitting
5. Land use planning
6. Pricing
7. Use restrictions

Review of the survey results identified the following measures as socially-acceptable water conservation measures for the City of Eau Claire.

1. Education
2. Building codes
3. Retrofitting
4. Use restrictions

IV. TECHNICAL FEASIBILITY

As noted earlier, the level to which a water conservation plan can be implemented depends on the social acceptability and technical feasibility of the measures considered. A brief discussion of the evaluation of each measure, conclusion reached, assumed effect on demand, and cost of implementation follows.

Leak Detection and Metering

Public and distribution loss in Wisconsin can be as high as 50 percent. Leak detection and metering can reduce that figure to below 10 percent, as has been done in Eau Claire.

This measure is not applied in the water conservation plan because it has already been implemented in Eau Claire. The program applied by Eau Claire has had the following result (public and unaccounted for water use are shown as a percentage of total water pumped).

Table IV.1
Distribution Loss, 1979-1982

Year	Distribution Loss (%)
1979	15.29%
1980	17.04%
1981	11.9 %
1982	10.4 % - used for projections in MAIN II model

Pricing

Recent price increases have reduced the communities tolerance for this measure as a means to achieve water conservation. Price increase between 1981 and 1982, coupled with institutions of sewer treatment charges, (which effectively doubled rates) led to large reductions in industrial and residential use. It was the opinion that the elasticity of these sectors was used up and that any price increases in the near future would cause hardship.

Elasticity of Water Use by Sector
(1981-1982)

Residential	-.30
Commercial	+.61
Industrial	-.17

Building Codes - This measure was applied for this study. The following assumptions were made:

1. Projected growth in demand as a result of population increase (from MAIN II projections) in the residential, commercial, and dry industry secors would come from new construction.

2. This growth (for residential, commercial, and dry industry) was reduced by 15 percent, assuming installation of water conservation during construction.

3. Cost would be $6,300 annually.

Retrofit - This measure was applied to the Eau Claire plan with the following assumptions:

1. Retrofitted conservation devices would be applied to the current number of residences.

2. Current (1982) residential demand (average daily) would be reduced by 10 percent.

3. Cost would be $160,000 spread over 4 years (annualized at $16,900 per year at 8-1/2 percent for the 20-year study period).

Regulation - This measure was also evaluated for Eau Claire. The measure was assumed to affect peak demand only.

1. Peak demand reduction was assumed to be 10 percent.

2. Cost was assumed to be $5,000 per year (administration and enforcement).

Education - This measure was also applied to the Eau Claire study. The following assumptions were made:

1. A reduction of 5 percent in average daily demand.

2. Annual cost of $10,000 through the study period.

Without Conservation Alternatives

The process followed in preparation of this appendix (and that described in the procedures manual) involves projection of anticipated demand for water if no conservation measures are applied. As noted earlier, the MAIN II model was used to develop this unrestricted projection once the model had been calibrated to reflect water use for Eau Claire in 1982.

Tables IV.2, IV.3, IV.4, IV.5, and IV.6 provide the unrestricted MAIN II projections of water demand for Eau Claire. These projections are by sector (residential, commercial, industrial, and public) for the years 1982, 1992, and 2002. Table IV.7 summarizes the projections for these 5 years.

Each table also provides information about the level at which the projections were made (per capita, extrapolation, external).

Table IV.2
Summary of Municipal Water Requirements for City of Eau Claire, Wisconsin

Estimated Water Requirements for the Year 1982
(all values in gallons per day)

Type	Annual Average	Maximum Daily	Peak Hourly
Municipal	9,118,515	12,426,991	23,637,275
Residential	2,731,678	6,040,153	17,250,437
Commercial	1,807,892	3,173,021	8,441,911
Industrial	3,210,037	3,530,819	3,687,998
Public	511,225	511,225	511,225
Distribution Loss	857,684	857,684	857,684

Table IV.4
Summary of Municipal Water Requirements for City of Eau Claire, Wisconsin

Estimated Water Requirements for the Year 1987
(all values in gallons per day)

Type	Annual Average	Maximum Daily	Peak Hourly
Municipal	10,353,844	14,111,359	26,843,145
Residential	3,102,431	4,859,946	19,591,733
Commercial	2,053,266	3,603,676	9,587,679
Industrial	3,643,444	4,007,761	4,185,896
Public	586,061	586,061	586,061
Distribution Loss	974,092	974,092	974,092

Table IV.3
Summary of Municipal Water Requirements for City of Eau Claire, Wisconsin

Estimated Water Requirements for the Year 1992
(all values in gallons per day)

Type	Annual Average	Maximum Daily	Peak Hourly
Municipal	11,636,961	15,860,471	30,171,217
Residential	3,487,186	7,710,697	22,021,442
Commercial	2,307,906	4,050,593	10,776,715
Industrial	4,094,356	4,503,583	4,703,538
Public	652,616	652,616	652,616
Distribution Loss	1,094,896	1,094,896	1,094,896

Table IV.5
Summary of Municipal Water Requirements for City of Eau Claire, Wisconsin

Estimated Water Requirements for the Year 1997
(all values in gallons per day)

Type	Annual Average	Maximum Daily	Peak Hourly
Municipal	12,919,731	17,608,596	33,496,124
Residential	3,871,410	8,560,275	22,447,803
Commercial	2,562,195	4,496,895	11,9[illegible]4,113
Industrial	4,546,070	5,000,664	5,222,661
Public	724,522	724,522	724,522
Distribution Loss	1,215,534	1,215,534	1,215,534

Table IV.6
Summary of Municipal Water Requirements for City of Eau Claire, Wisconsin

Estimated Water Requirements for the Year 2002
(all values in gallons per day)

Type	Annual Average	Maximum Daily	Peak Hourly
Municipal	14,158,996	19,297,478	36,708,468
Residential	4,242,641	9,381,123	26,792,113
Commercial	2,807,885	4,928,104	13,111,35[illegible]
Industrial	4,982,381	5,480,509	5,723,568
Public	793,997	793,997	793,997
Distribution Loss	1,332,092	1,332,092	1,332,092

Table IV.7
Summary of Projected Municipal Water Requirements
for the City of Eau Claire, Wisconsin

(Gallons Per Day)

Run No.	Year	Mean Average	Maximum Day	Peak Hourly
1	1982	9,118,515	12,426,991	23,637,275
2	1987	10,353,884	14,111,359	26,843,145
3	1992	11,636,961	15,860,471	30,171,217
4	1997	12,919,731	17,608,596	33,496,124
5	2002	14,158,996	19,297,478	36,708,468

V. COST AND SCENARIO ANALYSIS

Implementation of water conservation measures would result in costs from the work required to implement the measure plus costs in the form of reduced revenues for the utility.

In Eau Claire, the benefits from delayed investment requirements would occur at some after the year 2002 because current water supply and wastewater treatment facilities would likely be sufficient to meet demand without water conservation to that date. A possible exception is the peak daily and hourly demand for water, which could equal capacity of 28 million gallons per day by the year 1992.

Reduction in operation and maintenance (O&M) costs can, however, be realized through water conservation. Determination of benefits from a reduction of these costs were based on the utility's annual report for 1982.* Table V.1 and V.2 display the O&M costs for water supply and wastewater treatment for Eau Claire.

Based on the data in Tables V.1 and V.2, the following variable costs per gallons were assumed:

Variable Costs - Water Supply

Water Pumped - 1982	3,142,744,170
Variable Costs - (Water Supply) - 1982	$1,006,326
Variable Cost/1000 gallons	$.32

Variable Costs - Wastewater Treatment

Water Pumped - 1982 (x 63%)	1,979,928,827
Variable Costs (wastewater treatment) - 1982	$952,881
Variable Cost/1000 gallons	$.48

The projections of water demand for the study period required that a "weighted" cost figure be obtained because projections were for water supply only, not for wastewater treatment. In Eau Claire during 1982, the wastewater treatment plant treated 63 percent of the water supplied by the utility.

The following figures were therefore used for the report.

$.32/1000	gallons of water supply
$.48/1000	gallons for wastewater treatment
$.80	Total variable cost per 1000 gallons supplied

Measurement of the net effect of conservation measures also requires that costs be compared to anticipated revenues. For this study, the following revenues per 1000 gallons were assumed:

Water Supply	$ .70/1000 gallons
Wastewater Treatment	$1.34/1000 gallons treated

These figures are based on revenues compared to total water supplied and treated in 1982.

*Dates are taken from:

Report on returns for the Eau Claire Municipal Water Utility, 1982.

Program Expenditures report for the Wastewater Treatment for Eau Claire, 1982.

Table V.1
1982 Water Supply Costs

Item	Fixed	Variable
Taxes	289,471	
Depreciation	250,683	
Source of Supply	18,725	29,480
Pumping Expenses	28,290	281,561
Water Treatment Expense	21,947	258,886
Transmission & Distribution Expense	20,184	352,210
Accounts Expense	5,612	84,189
Administration Expense	176,776	
Total	811,688	1,006,326

Costs	
Fixed	811,688
Variable	1,006,326
Grand Total	1,818,014
Minus	
Taxes and Depreciation	550,154
Returns on Investment	338,250
Total Operation and Maintenance Expense	929,610

Fixed Short-Run Water Supply Costs = 811,688 per year
Variable Short-Run Water Supply Costs = 1,006,326 per year

Table V.2
1982 Wastewater Treatment Costs

Item	Fixed*	Variable
Contractual Services	434,326	
Materials and Supplies	36,066	
Administration	54,731	
Capital Assets	2,421	
Sundry Charges*	1,145,895	
Electricity		120,901
Sanitary Sewer Service		19,618
Water Service		12,645

Repairs to Tools and Equipment	20,071
Other Maintenance	10,887
Fuel Oil	45,827
Motor Oil (lubricants)	5,561
Drugs, Chemicals, and Gases	7,705
Labor	709,576
Total	952,881
Fixed	1,673,439
Variable	952,881
Grand Total	2,626,320
Minus Taxes and Depreciation	203,912
Total Operation & Maintenance Expense	2,422,408

Fixed Short-Run Wastewater Treatment Costs = $1,673,439 per year
Variable Short-Run Wastewater Treatment Costs = $952,881 per year

* Sundry charges as listed on page 151 or the 1982 Program Expenditures report are:

Principal: Bonded Debt	422,250
Interest: Bonded Debt	65,785
Interest on Revenue Bonds	262,789
Administrative Charge	178,800
Claims and Judgments	12,359
Property Tax Equivalent	202,360
Real Estate Taxes/Special Assessment	1,552
	1,145,895

The projections of water demand for the study period required that a "weighted" revenue figure be obtained because projections were for water supply only, not for wastewater treatment. During 1982, the wastewater treatment plant treated 63 percent of the water supplied by the utility. The weighted cost figute that was derived therefore reflected 63 percent of the wastewater treatment cost per gallon. The following figutes were used for the report:

$ .7/1000 gallons of water supply
$ .84/gallons for wastewater treatment
$1.54 Total variable cost per 1000 gallons supplied

EFFECT OF CONSERVATION MEASURES

The measures applied in this study were education and regulation (building codes, retrofit, and regulation of peak uses). Each measure was analyzed for its individual effect on unrestricted use, and the measures were also analyzed in combination. The means of selection differs from that suggested in the Water Conservation Procedure Manual: the selection was based on the social acceptability of the measures, not on the anticipated order of savings in water supply. The order selected therefore was as follows:

1. Education.

2. Building codes for new residential, commercial, and dry industry construction.

3. Retrofit of existing residential, commercial, and dry industry users.

4. Regulation of peak demand.

Tables V.3 and V.4 display the net effect of the conservation measures that were analyzed for this report. Table V.5 and V.6 present the effect on revenue of the various conservation plans.

These analyses do not address the "wet" industries in Eau Claire. Discussion with industry managers and personnel within the Eau Claire Public Works Department indicated that "wet" industries are really only responsive to price increases. In addition, the effects on the industries from retrofitting, building codes, and education were impossible to measure. Because pricing, as a conservation measure was not tried, the projection for these industries were left unchanged under each conservation measure and under the conservation scenario.

Projections for the public sector are also shown to be unaffected by the conservation measures. As noted in chapter II, the potential water supply management measures were deemed inappropriate because Eau Claire has reduced the unaccounted-for losses to a low level through metering and leak detection. Other supply management measures are not applicable because Eau Claire uses groundwater as its supply source.

Figures V.1 through V.6 present a graphic display, by sector, of the effect of the conservation measures individually and combined into the selected conservation scenario.

Table V.3

Effect of Conservation Measures on Water Demand
1987 and 1992

AVERAGE ANNUAL INDIVIDUAL MEASURES (1)

(ALL VALUES IN GALLONS/DAY) YEAR 1987		RESIDENTIAL	COMMERCIAL	DRY (6) INDUSTRY	WET (7) INDUSTRY	PUBLIC MEASURES	TOTAL GALLONS
NO CONSERVE	(2)	3,102,431	2,053,266	132,949	3,510,495	1,554,703	10,353,844
EDUCATION	(3)	2,947,309	1,950,603	126,302	3,510,495	1,554,703	10,089,412
CODES	(4)	3,046,818	2,016,460	130,646	3,510,495	1,554,703	10,259,122
RETROFIT	(5)	2,829,263	1,872,477	121,190	3,510,495	1,554,703	9,888,128

AVERAGE ANNUAL COMBINED MEASURES (8)

(ALL VALUES IN GALLONS/DAY) YEAR 1987	RESIDENTIAL	COMMERCIAL	DRY INDUSTRY	WET INDUSTRY	PUBLIC MEASURES	TOTAL GALLONS
NO CONSERVE	3,102,431	2,053,266	132,949	3,510,495	1,554,703	10,353,844
EDUCATION	2,947,309	1,950,603	126,302	3,510,495	1,554,703	10,089,412
CODES	2,837,182	1,877,717	121,607	3,510,495	1,554,703	9,901,703
RETROFIT	2,496,720	1,652,391	107,014	3,510,495	1,554,703	9,321,323

AVERAGE ANNUAL INDIVIDUAL MEASURES

(ALL VALUES IN GALLONS/DAY) YEAR 1992	RESIDENTIAL	COMMERCIAL	DRY INDUSTRY	WET INDUSTRY	PUBLIC MEASURES	TOTAL GALLONS
NO CONSERVE	3,487,186	2,307,906	149,367	3,944,989	1,747,512	11,636,960
EDUCATION	3,312,827	2,192,511	141,899	3,944,989	1,747,512	11,339,737
CODES	3,373,860	2,232,904	144,601	3,944,989	1,747,512	11,443,866
RETROFIT	3,214,018	2,127,117	137,608	3,944,989	1,747,512	11,171,244

AVERAGE ANNUAL COMBINED MEASURES

(ALL VALUES IN GALLONS/DAY) YEAR 1992	RESIDENTIAL	COMMERCIAL	DRY INDUSTRY	WET INDUSTRY	PUBLIC MEASURES	TOTAL GALLONS
NO CONSERVE	3,487,186	2,307,906	149,367	3,944,989	1,747,512	11,636,960
EDUCATION	3,312,827	2,192,511	141,899	3,944,989	1,747,512	11,339,737
CODES	3,200,956	2,118,472	137,729	3,944,989	1,747,512	11,149,658
RETROFIT	2,781,399	1,840,799	119,671	3,944,989	1,747,512	10,434,370

(1) The effect of each measure is displayed individually.
(2) No Conserve - No conservation measures are used.
(3) Education - A 5% reduction on residential, commercial, and dry industrial.
(4) Codes - A 15% reduction on new residential, commercial, and dry industrial.
(5) Retrofit - A 10% reduction on existing residential, commercial, and dry industrial.
(6) Dry Industry - Industries that do not use water for production.
(7) Wet Industry - Industries which use water for production.
(8) The effect of each measure is applied to that measure preceding it - the selected conservation scenario.

Table V.4

Effect of Conservation Measures on Water Demand
1997 and 2002

AVERAGE ANNUAL INDIVIDUAL MEASURES (1)
(ALL VALUES IN GALLONS/DAY)

YEAR 1997	RESIDENTIAL	COMMERCIAL	DRY (6) INDUSTRY	WET (7) INDUSTRY	PUBLIC MEASURES	TOTAL GALLONS
NO CONSERVE (2)	3,871,410	2,562,195	165,649	4,380,421	1,940,056	12,919,731
EDUCATION (3)	3,677,840	2,434,085	157,367	4,380,421	1,940,056	12,589,768
CODES (4)	3,700,450	2,449,050	158,441	4,380,421	1,940,056	12,628,417
RETROFIT (5)	3,598,242	2,381,406	153,890	4,380,421	1,940,056	12,454,015

AVERAGE ANNUAL COMBINED MEASURES (8)
(ALL VALUES IN GALLONS/DAY)

YEAR 1997	RESIDENTIAL	COMMERCIAL	DRY INDUSTRY	WET INDUSTRY	PUBLIC MEASURES	TOTAL GALLONS
NO CONSERVE	3,871,410	2,562,195	165,649	4,380,421	1,940,056	12,919,731
EDUCATION	3,677,840	2,434,085	157,367	4,380,421	1,940,056	12,589,768
CODES	3,509,269	2,322,522	150,186	4,380,421	1,940,056	12,302,454
RETROFIT	3,053,064	2,020,594	130,662	4,380,421	1,940,056	11,524,797

AVERAGE ANNUAL INDIVIDUAL MEASURES
(ALL VALUES IN GALLONS/DAY)

YEAR 2002	RESIDENTIAL	COMMERCIAL	DRY INDUSTRY	WET INDUSTRY	PUBLIC MEASURES	TOTAL GALLONS
NO CONSERVE	4,242,641	2,807,885	181,871	4,800,510	2,126,089	14,158,996
EDUCATION	4,030,509	2,667,491	172,777	4,800,510	2,126,089	13,797,376
CODES	4,015,997	2,657,886	172,229	4,800,510	2,126,089	13,772,711
RETROFIT	3,969,473	2,627,096	170,112	4,800,510	2,126,089	13,693,280

AVERAGE ANNUAL COMBINED MEASURES
(ALL VALUES IN GALLONS/DAY)

YEAR 2002	RESIDENTIAL	COMMERCIAL	DRY INDUSTRY	WET INDUSTRY	PUBLIC MEASURES	TOTAL GALLONS
NO CONSERVE	4,242,641	2,807,885	181,871	4,800,510	2,126,089	14,158,996
EDUCATION	4,030,509	2,667,491	172,777	4,800,510	2,126,089	13,797,376
CODES	3,780,484	2,459,943	162,154	4,800,510	2,126,089	13,329,180
RETROFIT	3,331,950	2,199,204	142,354	4,800,510	2,126,089	12,600,107

(1) The effect of each measure is displayed individually.
(2) No Conserve - No conservation measures are used.
(3) Education - A 5% reduction on residential, commercial, and dry industrial.
(4) Codes - A 15% reduction on new residential, commercial, and dry industrial.
(5) Retrofit - A 10% reduction on existing residential, commercial, and dry industrial.
(6) Dry Industry - Industries that do not use water for production.
(7) Wet Industry - Industries which use water for production.
(8) The effect of each measure is applied to that measure preceding it - the selected conservation scenario.

Table V.5

Effect of Conservation Measures on Total (Net) Income
1987 and 1992

AVERAGE ANNUAL INDIVIDUAL MEASURES

YEAR 1987	REVENUE (1) 1987 $	VARIABLE (2) COSTS	INITIAL (3) OPERATION	FIXED (4) COSTS	TOTAL COST	TOTAL (5) NET INCOME
NO CONSERVE	$5,346,884	$3,025,393	$0.00	$2,485,127	$5,510,520	($163,637)
EDUCATION	$5,198,144	$2,948,126	$10,000	$2,485,127	$5,443,253	($245,109)
CODES	$5,293,604	$2,997,715	$0.00	$2,485,127	$5,482,842	($189,239)
RETROFIT	$5,084,925	$2,889,311	$16,900	$2,485,127	$5,391,338	($306,413)

AVERAGE ANNUAL COMBINED MEASURES

YEAR 1987	REVENUE 1987 $	VARIABLE COSTS	INITIAL OPERATION	FIXED COSTS	TOTAL COST	TOTAL NET INCOME
NO CONSERVE	$5,346,884	$3,025,393	$0.00	$2,485,127	$5,510,520	($163,637)
EDUCATION	$5,198,144	$2,948,126	$10,000	$2,485,127	$5,443,253	($245,109)
CODES	$5,092,561	$2,893,278	$10,000	$2,485,127	$5,388,405	($295,844)
RETROFIT	$4,766,106	$2,723,691	$26,900	$2,485,127	$5,235,718	($469,612)

AVERAGE ANNUAL INDIVIDUAL MEASURES

YEAR 1992	REVENUE 1992 $	VARIABLE COSTS	INITIAL OPERATION	FIXED COSTS	TOTAL COST	TOTAL NET INCOME
NO CONSERVE	$6,009,461	$3,400,320	$0.00	$2,485,127	$5,885,447	$124,015
EDUCATION	$5,842,278	$3,313,471	$10,000	$2,485,127	$5,808,598	$33,680
CODES	$5,900,849	$3,343,898	$0.00	$2,485,127	$5,829,025	$71,824
RETROFIT	$5,747,503	$3,264,237	$16,900	$2,485,127	$5,766,264	($18,762)

AVERAGE ANNUAL COMBINED MEASURES

YEAR 1992	REVENUE 1992 $	VARIABLE COSTS	INITIAL OPERATION	FIXED COSTS	TOTAL COST	TOTAL NET INCOME
NO CONSERVE	$6,009,461	$3,400,320	$0.00	$2,485,127	$5,885,447	$124,015
EDUCATION	$5,842,278	$3,313,471	$10,000	$2,485,127	$5,808,598	$33,680
CODES	$5,735,361	$3,257,930	$10,000	$2,485,127	$5,753,057	($17,696)
RETROFIT	$5,333,022	$3,048,923	$26,900	$2,485,127	$5,560,950	($227,927)

Table V.6

Effect of Conservation Measures on Total (Net) Income
1997 and 2002

AVERAGE ANNUAL INDIVIDUAL MEASURES

YEAR 1997	REVENUE (1) 1997 $	VARIABLE (2) COSTS	INITIAL (3) OPERATION	FIXED (4 COSTS	TOTAL COST	TOTAL (5) NET INCOME
NO CONSERVE	$6,671,926	$3,775,145	$0.00	$2,485,127	$6,260,272	$411,654
EDUCATION	$6,486,327	$3,678,730	$10,000	$2,485,127	$6,173,857	$312,470
CODES	$6,508,067	$3,690,024	$0.00	$2,485,127	$6,175,151	$332,916
RETROFIT	$6,409,968	$3,639,063	$16,900	$2,485,127	$6,141,090	$268,878

AVERAGE ANNUAL COMBINED MEASURES

YEAR 1997	REVENUE 1997 $	VARIABLE COSTS	INITIAL OPERATION	FIXED COSTS	TOTAL COST	TOTAL NET INCOME
NO CONSERVE	$6,671,926	$3,775,145	$0.00	$2,485,127	$6,260,272	$411,654
EDUCATION	$6,486,327	$3,678,730	$10,000	$2,485,127	$6,173,857	$312,470
CODES	$6,324,717	$3,594,777	$10,000	$2,485,127	$6,089,904	$234,813
RETROFIT	$5,887,297	$3,367,546	$26,900	$2,485,127	$5,879,573	$7,724

AVERAGE ANNUAL INDIVIDUAL MEASURES

YEAR 2002	REVENUE 2002 $	VARIABLE COSTS	INITIAL OPERATION	FIXED COSTS	TOTAL COST	TOTAL NET INCOME
NO CONSERVE	$7,311,917	$4,137,259	$0.00	$2,485,127	$6,622,386	$689,532
EDUCATION	$7,108,512	$4,031,593	$10,000	$2,485,127	$6,526,720	$581,791
CODES	$7,094,638	$4,024,386	$0.00	$2,485,127	$6,509,513	$585,125
RETROFIT	$7,049,959	$4,001,176	$16,900	$2,485,127	$6,503,203	$546,756

AVERAGE ANNUAL COMBINED MEASURES

YEAR 2002	REVENUE 2002 $	VARIABLE COSTS	INITIAL OPERATION	FIXED COSTS	TOTAL COST	TOTAL NET INCOME
NO CONSERVE	$7,311,917	$4,137,259	$0.00	$2,485,127	$6,622,386	$689,532
EDUCATION	$7,108,512	$4,031,593	$10,000	$2,485,127	$6,526,720	$581,791
CODES	$6,845,158	$3,894,786	$10,000	$2,485,127	$6,389,913	$455,245
RETROFIT	$6,435,066	$3,681,751	$26,900	$2,485,127	$6,193,778	$241,288

Figure V.1

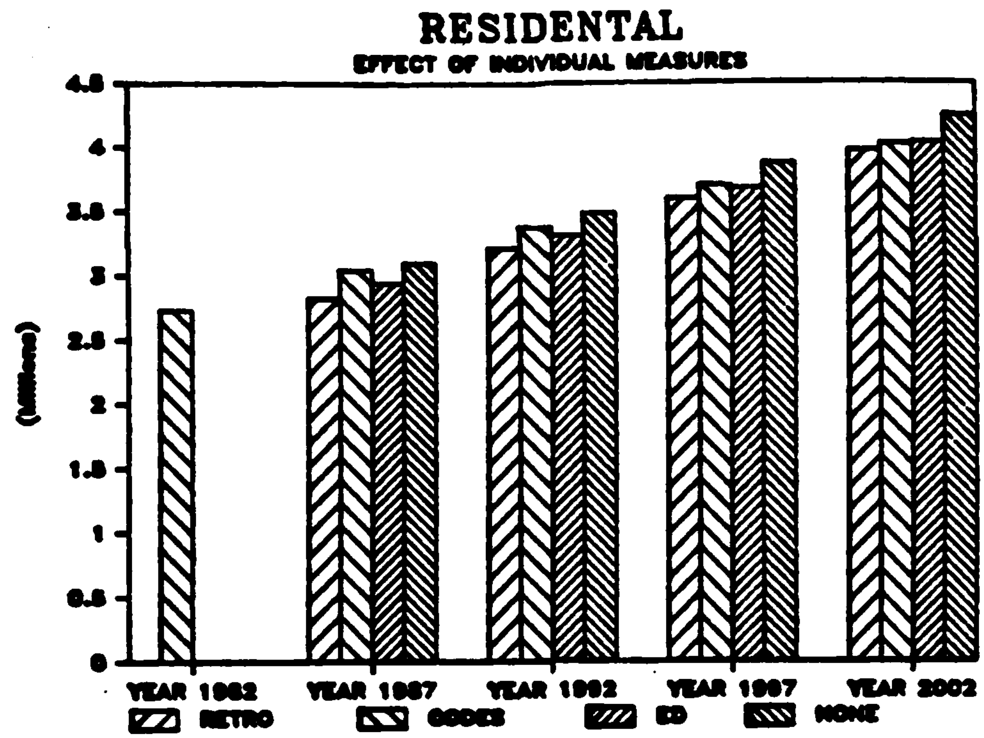
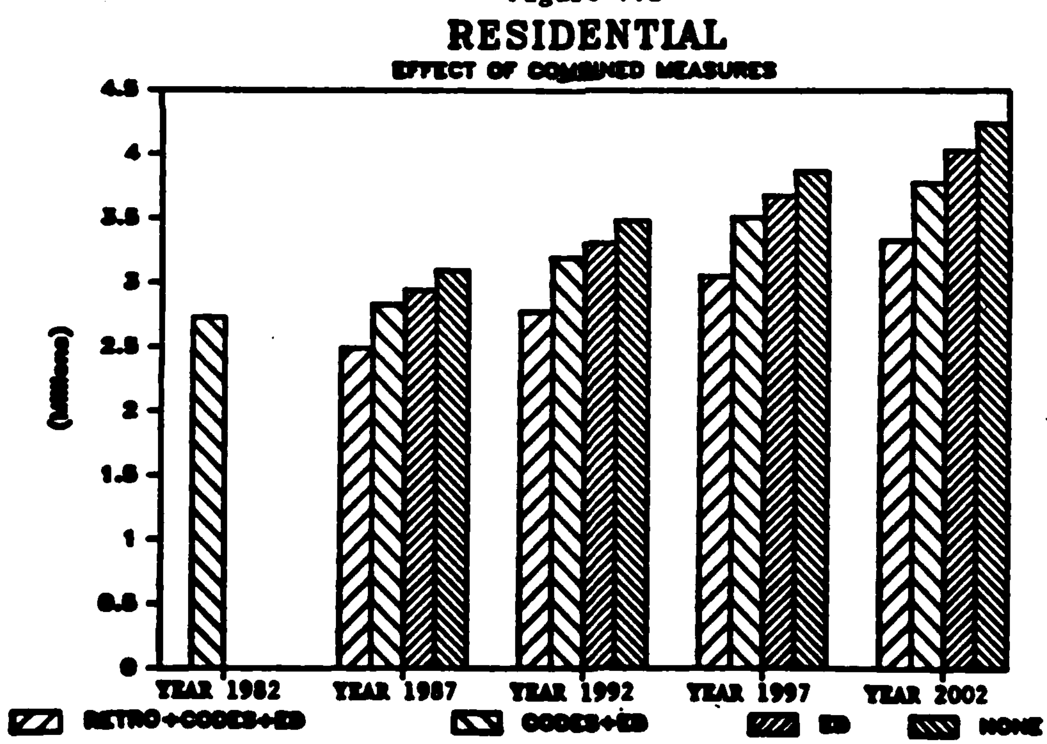


Figure V.2



NONE - NO CONSERVATION MEASURES ARE USED.
ED - A 5% REDUCTION ON RESIDENTIAL, COMMERCIAL, AND DRY INDUSTRIAL USE.
CODES - A 15% REDUCTION ON NEW RESIDENTIAL, COMMERCIAL, AND DRY INDUSTRIAL USE.
RETRO - A 10% REDUCTION ON EXISTING RESIDENTIAL, COMMERCIAL, AND DRY INDUSTRIAL USE.

Table V.3

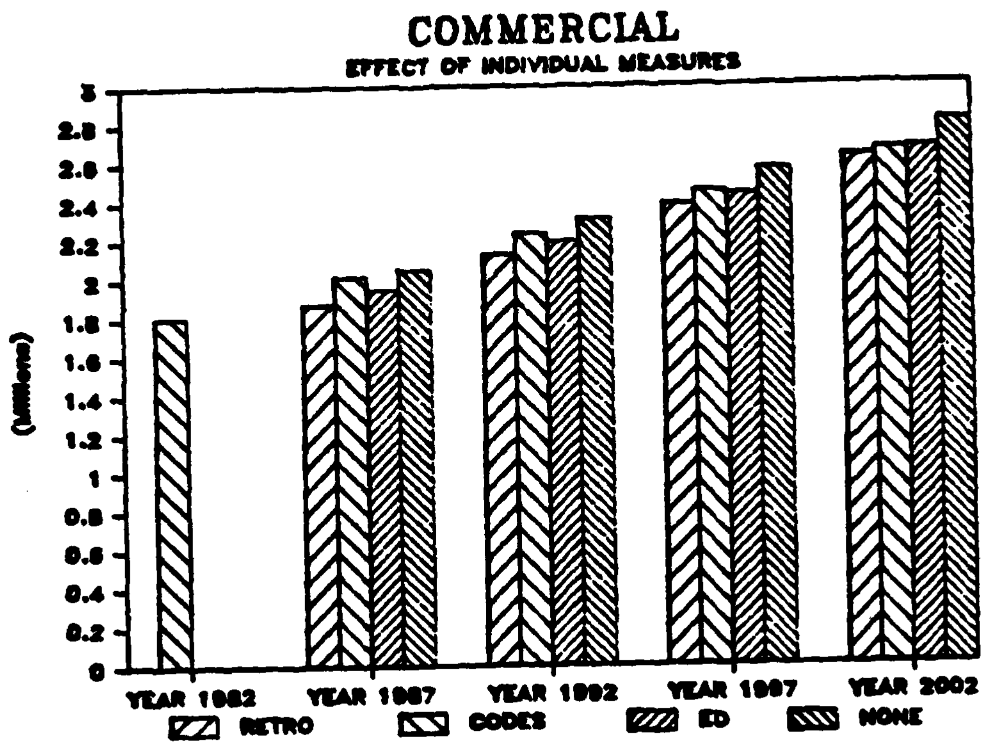
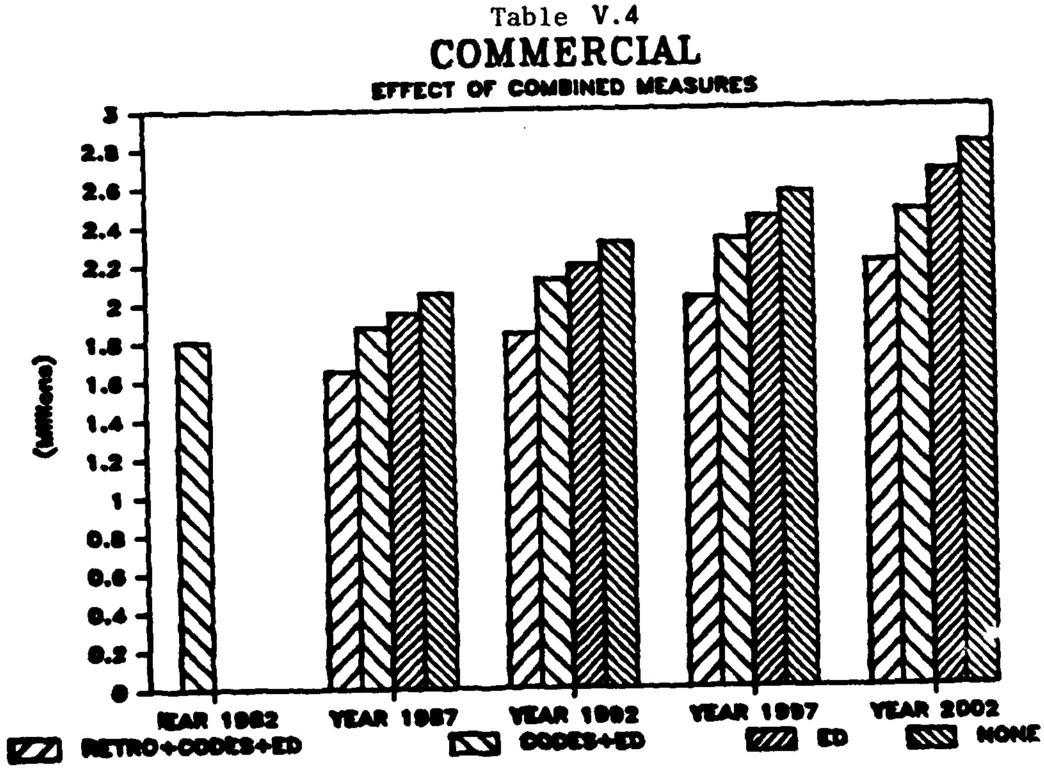


Table V.4



NONE - NO CONSERVATION MEASURES ARE USED.
ED - A 5% REDUCTION ON RESIDENTIAL, COMMERCIAL, AND DRY INDUSTRIAL USE.
CODES - A 15% REDUCTION ON NEW RESIDENTIAL, COMMERCIAL, AND DRY INDUSTRIAL USE.
RETRO - A 10% REDUCTION ON EXISTING RESIDENTIAL, COMMERCIAL, AND DRY INDUSTRIAL USE.

Table V.5

DRY INDUSTRIAL

EFFECT OF INDIVIDUAL MEASURES

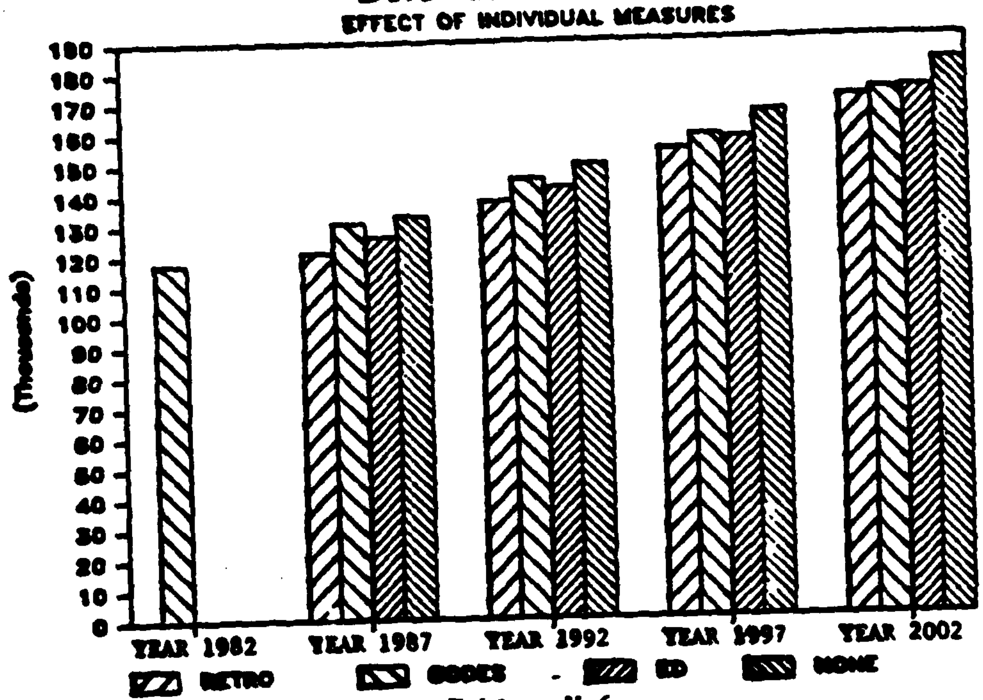
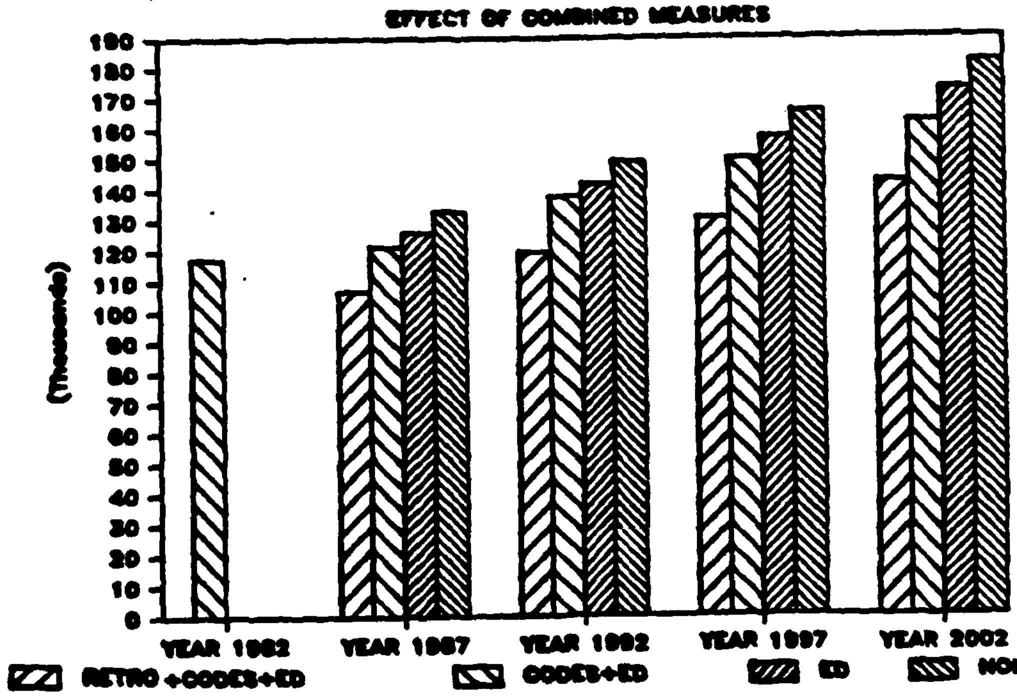


Table V.6

DRY INDUSTRIAL

EFFECT OF COMBINED MEASURES



NONE - NO CONSERVATION MEASURES ARE USED.
ED - A 5% REDUCTION ON RESIDENTIAL, COMMERCIAL, AND DRY INDUSTRIAL USE.
CODES - A 15% REDUCTION ON NEW RESIDENTIAL, COMMERCIAL, AND DRY INDUSTRIAL USE.
RETRO - A 10% REDUCTION ON EXISTING RESIDENTIAL, COMMERCIAL, AND DRY INDUSTRIAL USE.

This discussion does not address the effect of regulations designed to reduce peak use requirements. MAIN II projects peak use during the study period in Eau Claire to reach the following demand figures.

Year	Maximum Day	Peak Hour
1982	12,426,991	23,637,275
1987	14,111,359	26,843,145
1992	15,860,471	30,171,217
1997	17,608,596	33,496,124
2002	19,297,478	36,708,468

The maximum well capacity of the current water supply system is 35 million gallons per day (MGD), while the actual system's pumping capacity is 21 MGD. A comparison of projected peak demands with current capacity indicates that system expansion will be necessary at about the end of the study period. For this report, the estimate for three wells from the Strand report (Eau Claire, Wisconsin, Report on Water Utility) was used. That estimate in 1982 dollars is $546,000 (update of January 1980 estimate of $432,000 to December 1982 price levels).

Regulation of peak demand could postpone that investment by 10 years (estimated because the study period terminated at the approximate time that expansion would be necessary). A 10-year delay in the need to add these three wells would result in a present-day savings of $70,100, assuming the following:

Present worth of $546,000 expenditure 18 years hence	$125,700	(8-1/2%)
Present worth of $546,000 expenditure 28 years hence	$ 55,600	(8-1/2%)
Difference	$ 70,100	

Additional cost savings would result from reduced marginal costs for delivering that water. Inflation is not figured into these calculations because inflated dollars are used for both cost and revenue of the expenditure.

Figures V.7 through V.10 illustrate the effect that a 30-percent reduction in peak (seasonal) demand would have on projected pumpage in 1987, 1992, and 1997. The peak 2002 reduction is assumed to be achieved through regulations (prohibition, schedule, restriction).

To obtain this peak reduction, a winter (September-April) average was identified. The non-winter use (the amount over the average) was then reduced by 30 percent, producing the pumpage reduction figures (see the table accompanying figures V. 7 through V.10). The projected pumpage figures were then reduced by the pumpage reduction to produce the total peak reduction. This reduction occurred only in the four peak summer months (May-August) where the peak reduction measures mentioned earlier would apply directly to the projected pumpage. For further information on peak reduction, see Fiscal Planning and Water Conservation in Madison, Wisconsin in Appendix C.

With the refinements mentioned in this section, the MAIN II estimate falls within the accepted level of 10 percent error. The overall municipal estimate is only 2.5 percent over the actual use, since estimates in the commercial and industrial sectors are higher than actual use, but the estimate in the residential sector is lower than actual use, and cancelling of errors in the aggregate occurs.

estimates in the commercial and industrial sectors are higher than actual use, but the estimate in the residential sector is lower than actual use, and cancelling of errors in the aggregate occurs.

PEAK REDUCTION

YEAR 1987

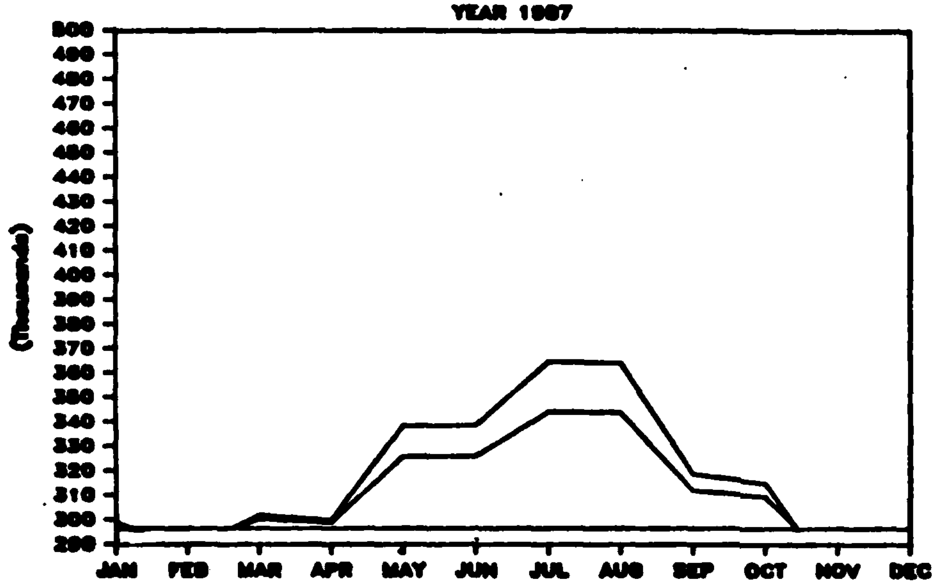


Figure V.7

PEAK REDUCTION, 1987

1987 MONTH	PROJECTED PUMPAGE		PUMPAGE REDUCTION		PEAK REDUCT MEASURES
JANUARY	299251	-	298484	=	0
FEBRUARY	287181	-	290035	=	0
MARCH	302094	-	300474	=	0
APRIL	299811	-	298876	=	0
MAY	338521	-	325973	=	12548
JUNE	338741	-	326127	=	12614
JULY	364550	-	344193	=	20357
AUGUST	363802	-	343670	=	20133
SEPTEMBER	318702	-	312099	=	0
OCTOBER	314895	-	309435	=	0
NOVEMBER	273328	-	280338	=	0
DECEMBER	278288	-	283810	=	0

PEAK REDUCTION

YEAR 1992

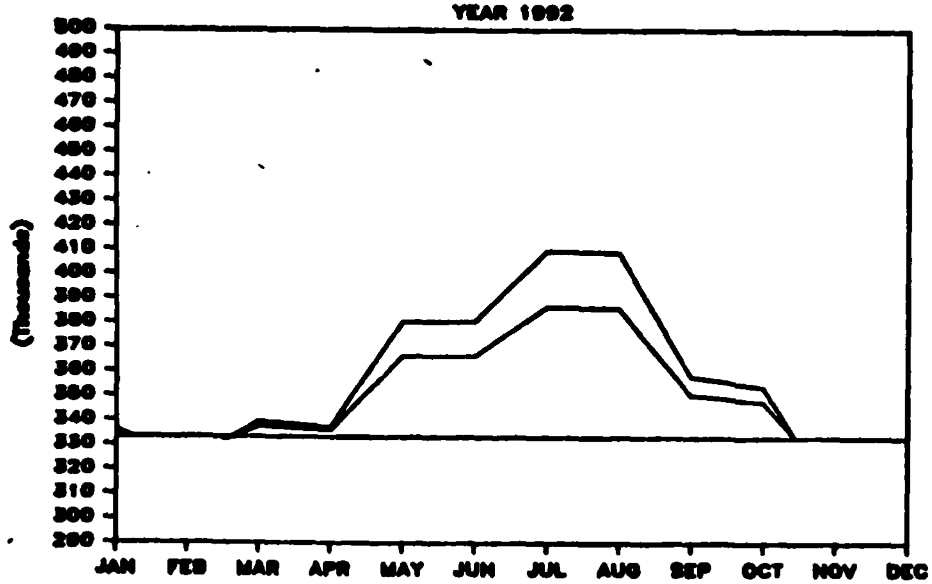


Figure V.8

PEAK REDUCTION, 1992

1992 MONTH	PROJECTED PUMPAGE		PUMPAGE REDUCTION		PEAK REDUCT MEASURES
JANUARY	336333	-	335471	=	0
FEBRUARY	322768	-	325975	=	0
MARCH	339529	-	337708	=	0
APRIL	336963	-	335912	=	0
MAY	380470	-	366367	=	14103
JUNE	380717	-	366539	=	14177
JULY	409724	-	386845	=	22880
AUGUST	408884	-	386256	=	22627
SEPTEMBER	358194	-	350774	=	0
OCTOBER	353916	-	347779	=	0
NOVEMBER	307198	-	315077	=	0
DECEMBER	312773	-	318978	=	0

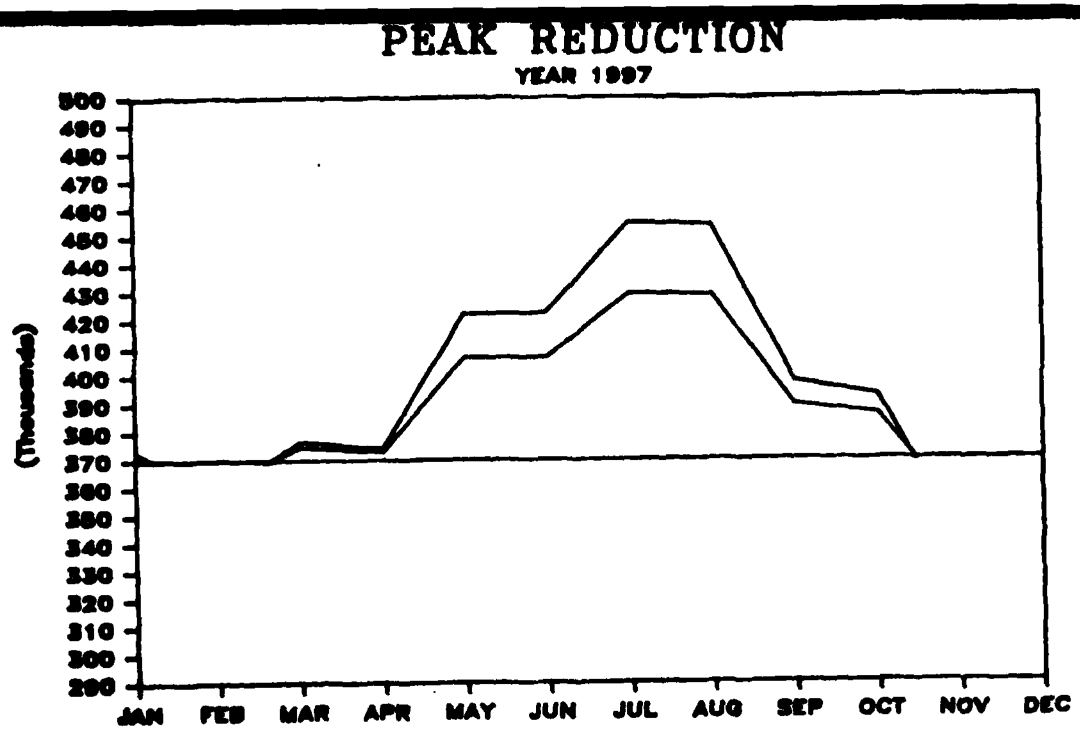


Figure V.9

PEAK REDUCTION, 1997

1997 MONTH	PROJECTED PUMPAGE		PUMPAGE REDUCTION		PEAK REDUCT MEASURES
JANUARY	373409	-	372452	=	0
FEBRUARY	358348	-	361909	=	0
MARCH	376957	-	374935	=	0
APRIL	374108	-	372941	=	0
MAY	422411	-	406753	=	15658
JUNE	422685	-	406945	=	15740
JULY	454891	-	429489	=	25402
AUGUST	453957	-	428835	=	25122
SEPTEMBER	397680	-	389441	=	0
OCTOBER	392930	-	386117	=	0
NOVEMBER	341063	-	349809	=	0
DECEMBER	347251	-	354141	=	0

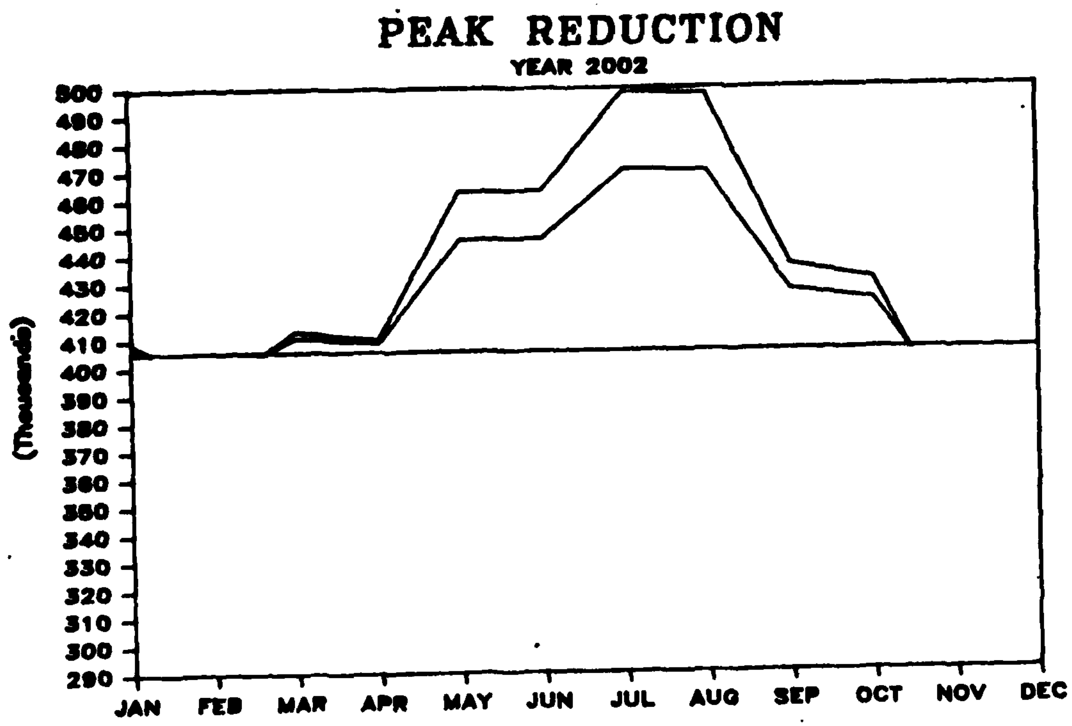


Figure V.10
PEAK REDUCTION, 2002

2002 MONTH	PROJECTED PUMPAGE		PUMPAGE REDUCTION		PEAK REDUCT MEASURES
JANUARY	409228	-	408179	=	0
FEBRUARY	392722	-	396625	=	0
MARCH	413115	-	410900	=	0
APRIL	409993	-	408715	=	0
MAY	462930	-	445770	=	17160
JUNE	463230	-	445981	=	17250
JULY	498525	-	470687	=	27838
AUGUST	497502	-	469971	=	27531
SEPTEMBER	435826	-	426798	=	0
OCTOBER	430621	-	423154	=	0
NOVEMBER	373778	-	383364	=	0
DECEMBER	380560	-	388112	=	0

VI. CONCLUSIONS

This water conservation study of Eau Claire addresses only some of the measures that can be applied to reduce the demand for water. It must, however, be reemphasized that, because of actions by the city (water supply management measures and prices that made increases in the cost of water socially unacceptable), certain measures that would be applicable elsewhere were not analyzed for the study.

Chapter V displayed a set of conservation measures that were combined as a recommended scenario. While the net effect of these measures is the same, the city might wish to gradually phase in measures at minimum cost. If this situation developed, consideration should perhaps first be given enactment of building codes that would require use of water conservation devices. The effect, at no cost to the city, would be considerably by the end of the study period.

The effect of water conservation should not be measured only against anticipated supply shortcomings. Savings in energy, treatment of supply, and wastewater can be considerable for both the utility and the general public.

Although the effect of pricing water as a conservation measure was not addressed, the effect of price can be considerable. A comparison of the water/sewer price increases between 1981 and 1982 to the changes in consumption shows that residential and industrial users reduced their consumption. The only increase in water use during that period was in the commercial sector.

It should be noted that no attempts were made to identify other variables that affect changes in consumption. The residential and industrial figures do indicate high levels of elasticity that imply the use of price as a means to conserve water could be quite effective. This measure must, however, be socially acceptable, which was not the case in Eau Claire, Wisconsin, at the time of the study.

This analysis done for Eau Claire indicated that implementation of conservation measures would reduce revenues below costs. When reduced revenues are anticipated, the community should consider refinancing its fixed costs over a longer period. Table VI.1 outlines the effects of refinancing in 1982, 1987, 19992, 1997, and 2002.

The basic premise of refinancing is to establish a "new" revenue that uses the community's existing rate charges. Most water utilities sell water under at least a two-step structure:

1. A minimum quarterly charge for a specified hookup to the system. In the City of Eau Claire system, this charge is $10.50 for a 5/8-inch hookup.

2. A bulk rate for all water over a minimum quantity. In the City of Eau Claire, the charge for the first 7,500 cubic feet is $.41 per 100 cubic fee of water used, plus an additional charge for anything over this minimum and a charge of $.34 per 100 cubic feet for water used over the initial 7500 cubic feet.

APPENDIX D

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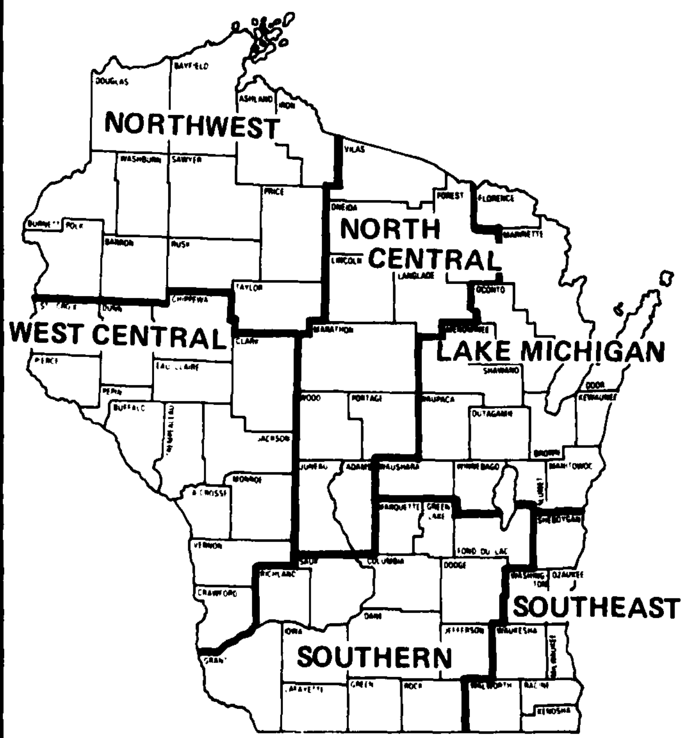

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